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CALCULATION OF ALTERNATING-CURRENT TRANSMISSION CIRCUITS.

The article in another column by Mr. P. M. Heldt, on "The Calculation of Alternating-Current Transmission Circuits," explains in a very clear and simple manner the method of calculating the factors to apply in the determination of the size of conductors for alternating circuits, the numerical examples illustrating the method to those who do not care to follow the mathematical reasoning. It should be remarked, however, that the factor by means of which the weight of copper for an alternating system may be obtained from the simple calculation on the basis of an effective current, cannot, if it includes the power factor or that relating to the induction of the line, be used without reference to the conditions of the transmission. In the former case it should be borne in mind that motors at full load have their current and E. M. F. nearly in phase. Therefore what lag there will be on the line would depend upon the character of the motor load, and the power factor would therefore be very small if the loads of the various motors were kept at their maximum, as in pumping. The lag due to inductance, as calculated from the geometry of the line, may also be influenced by the motors in circuit, and in the future may probably be neutralized in most cases by over-excited synchronous motors on the line, such motors having an action equivalent to condensers. Another point to be observed is that comparisons between different alternating systems on the basis of maximum insulation stress cannot be given the full weight indicated by the calculated ratios until voltages are reached at which insulation strain becomes a matter of prime importance. At 100 volts effective, for example, a system otherwise requiring the same copper on the basis of effective E. M. F. as a second system, would have little or no superiority over the latter from the fact that with it the maximum insulation stress was, say, a half less. It would not be until after a considerable increase of voltage that real advantage would thus appear, and not until approaching a point where the maximum voltage of the second system was nearing the limit of insulation strain could the ratio be accepted at its numerical value.

UNIT SYSTEMS AND DIMENSIONS.

In the discussion of units and their dimensions with respect to the connection between different classes of phenomena, the C. G. S. system is usually accepted as representative of nature, and the causes of discordances between the several classes as concerns dimensions, ascribed to physical reasons. In another column Mr. T. Proctor Hall shows that the C. G. S. system is itself an arbitrary one, and for that reason may therefore naturally give rise to disparities between classes. He points out that a relation, which by definition, fixes the value of a unit, should, if possible, apply to all quantities to be measured by that unit, and that the law of gravitation, which most nearly satisfies that condition, if chosen as a base, enables a system to be constructed having only two fundamental units —the second and the centimetre. In this case mass is eliminated for the reason that as unit mass is that mass which produces at unit distance unit acceleration, its dimensions are in terms of those of distance and acceleration—that is, of length and time only. Pursuing this method a step further, if the properties of the ether are used as a base, only one dimension is needed, since in ether waves there is a fixed natural relation between length and time, and, therefore, the latter unit may be derived from the former. In this system the disparity between the dimensions of the electrostatic and electromagnetic units disappear. Whether, if we could remake our

systems of practical units, it would be possible to base them upon this latter relation, is, however, not the only consideration to be kept in view. In a single dimension, or even a double dimension system, the fundamental relation involves for its understanding the ideas whose expression has been obliterated. The idea of force, for example, involves that of mass, and in the single or double dimension system, the relation by means of which mass as a dimension has been suppressed, must be borne in mind or the dimension of force in either of those systems is senseless. In the C. G. S. system, however, the physical properties of force are directly represented in its dimensional equation. Rational units can, therefore, be at once derived from it, whereas in the single dimension system two steps are necessary, and in the double dimension system, one step, before we reach that point. Nevertheless, it is instructive to discuss the subject of dimensional systems, and every elementary text-book of science should have a chapter in which their theory should be treated, if for no other reason than to teach the student that, after all, unit systems are not of divine origin, but human contrivances containing disparities due to practical considerations which should be explained.

THE NEW PHOTOGRAPHY.

Few discoveries in science, if indeed any, have ever created as immediate, eager and world-wide an interest as that of Prof. Röntgen relating to dark-wave photography, and none certainly has ever approached it in containing both popular and scientific elements equally of the grandest importance. From the *resumé* we give in another column of the more authoritative matter thus far printed concerning the discovery, it will be seen that the wonder of it was not exaggerated in the first reports, incredulous as they seemed. Further experiments have emphasized its practical importance and the scientific vista opened is one of magnificent extent. The practical results seem likely to be of the most manifold nature, extending from the realm of the physician to that of the engineer and mechanic. But it is needless to dwell on this aspect, as the imagination of all can clearly seize its significance. As to the scientific import, at this writing authorities seem to be entirely at sea in regard to the nature of the vibrations, and until this is established, opinions are largely speculative. As remarked by Prof. Dolbear, the phenomena discovered have been predicated, and Prof. Bell twenty years ago showed that vibrations affecting a sensitive film could be passed through ebonite. In the light of the experiments of Hertz, as much could have been ventured at any time during recent years, but it is possible that the Röntgen radiations may be of an entirely different character from those on which such anticipations would have been based. At the present time it is uncertain whether the rays correspond to the ultra-red or ultra-violet part of the spectrum. As shown elsewhere, hypotheses based upon either of these assumptions are in turn each supported and denied by the results of the experiments thus far made. Profs. Röntgen and Hall are even not certain that the sensitive plates are directly affected by the rays, as fluorescent light generated on the film or glass may be the active agent. Nor can it be assumed that the rays are identical with cathode rays, to which, however, they may owe their origin. Unlike ultra-violet and Hertzian rays, their powers of reflection and refraction are small, if existing at all. It will thus be seen that the Röntgen radiations as yet cannot be definitely placed, nor the nature of their action in picturing shadows more than surmised. Their elusive character has therefore led to the hypothesis that they are due to longitudinal vibrations, and in this lies their greatest scientific interest. For, should this be established as a fact, then the ether of the mathematical physicists will cease to be the "hypothetical ether," and be established as an entity. Should this consequence prove to be involved, it will mark the greatest triumph of scientific thought—indeed, the most notable achievement of the human intellect. And this explanation seems to be one having much probability in its favor. Though in cautious terms, it is advanced by Prof. Hall, and Prof. Röntgen goes so far—which for a German investigator is quite a distance—as to formally set it forth, with the remark that he puts more and more faith in its truth. Prof. Jaumann also adduces arguments in support of the longitudinal vibration property, though he assumes that Röntgen and cathode rays are identical, and shows that the equations of Maxwell and Hertz may be modified to take that property into consideration. This latter circumstance is in itself favorable, as it may lead to many deductions that will serve to guide further experiment. Aside from the direct effect of the new discovery, its importance will be extended by the impetus given research into etheric vibrations in general. Thus far the scale of vibrations has been considered in arbitrary sections—first in the visual portion, then the ultra-red and ultra-violet, next in the electromagnetic section, and now in a portion not yet placed, but in each case independently and without reference to the scale as a whole. The startling possibilities that may be in store in some of the gaps or beyond the present limits, should serve, in view of the results in the present case, to cause the subject to be vigorously taken up in its entirety, and, in time, thus establish the properties of vibrations throughout every part of their range that comes within the bounds of human detection. As pointed out by Prof. Dolbear, what other waves will do depends quite as much upon what they may chance to fall as upon the wave-length, and opacity and transparency are but relative terms. The latter properties will probably remain criteria for further investigations, but whether the photographic plate and the Hertzian vibrator will suffice to bridge all the gaps now remaining is more doubtful. The search for other indicators may consequently result in clearing up the mysteries of fluorescence, the sensory phenomena of lower animal life, and finally lead to a true knowledge of molecular mechanism, upon which may hinge the very ultimate problems of life and of the universe.

Massachusetts Street Railways.

The annual report of the State Railway Commission on Massachusetts streets railways was sent to the Legislature on January 31, and showed that eleven companies were chartered last year, six of which are being operated, while four have not been begun. The roads built last year comprised 149 miles of track. Massachusetts companies now own 1155 miles of track. The gross assets of the companies were, on September 30, $56,212,670. The total income from all sources for the year ending September 30 was $13,246,371; expenditures, $12,595,212, leaving a net balance to carry to the surplus of $651,159. Cash dividends of $1,606,196 were declared.

The report says that the growth of business was almost phenomenal. There were carried the previous year, in round numbers, 220,500,000 passengers; last year, 260,000,000, a larger increase than in any two preceding years combined. Of the 39,500,000 additional passengers carried, nearly 29,000,000 were carried on the railways of the eight largest established companies. Over 18,200,000 additional passengers were carried on the lines of the West End Railway alone. This company carried the last year 155,231,506 passengers, nearly 60 per cent. of the whole number carried on all the street railways of the State. The whole number of persons injured in connection with the street railway operations was 1507, of whom 25 received fatal injuries.

An Ingenious Inventor.

From a pamphlet descriptive of an "Electromagnetic Sub-trolley" system (which the title page states is endorsed by "Tesla"), and depending for its action upon a chain contact-making device actuated by an electromagnet in the street car, we quote the following: "The action of the chain under this combined influence is like *a rushing ripple*, its top grazing the inner surface of the rail, *as it follows its master the Magnet!*"—the italics and punctuation being as printed. The same pamphlet contains the following note: "The above inventor has recently filed an application for a patent for a new system of a Return Current by means of the Earth's Secondary or Storage Batteries, lessening the resistance of present methods and condensing the sparking of the Commutator."

Röntgen's Photographs.

BY A. E. DOLBEAR.

The photographs of Röntgen with the rays given by a Geissler tube, together with the comments made upon them, make it needful to review what has been known about the conditions for photographic action, in order to judge what advance, if any, has been made by the experiments.

1. It was shown by Prof. Bell nearly twenty years ago, that a sheet of ebonite which was perfectly opaque to light was quite transparent to ether waves longer than the red rays of the solar spectrum.

2. Draper discovered fifty years ago that photographic action took place in the same region of the spectrum, and later Abney and others have photographed the whole spectrum a long distance below the red end, so that it has been known that such rays as affect the eye and are called light are not essential for photographic work.

3. Again, since Hertz's work with ether waves produced by electrical means, showing that such waves could be refracted, reflected, polarized, and so on, like ordinary light, it has been perfectly apparent to every student that what we call light is only a physiological phenomenon, and has no existence apart from eyes ; that all ether waves are alike except in wave-lengths and amplitude. Hertz has taught us that whenever there are electrical discharges there ether waves are produced, which are of various heights, depending on a good many conditions, but moving and acting on other bodies like light waves.

4. It is well enough known that what ether waves will do depends quite as much upon what they chance to fall as upon their wave-length. It happens that ordinary silver salts in use in photography are more promptly affected by waves the fifty-thousandth of an inch long, while iron salts are more sensitive to longer ones, and very heavy molecules are only broken up by the action of longer waves.

Photography is not limited to any particular wave-lengths. Opacity and transparency are but relative terms, and depend upon wave, lengths, and long waves go freely through substances which are impervious to shorter ones.

It is not new to photograph with electric waves through opaque screens. In the April number of the *Cosmopolitan Magazine* for 1894, I described this phenonenon precisely, and there say: "*It is actually possible to take a photograph of an object in absolute darkness, with the ether waves set up by working an electric machine.*"

This is what Röntgen has done. He has shown that common tissue is transparent for such waves as he employed, while bone is less transparent. It must seem like a ghostly experiment to photograph the skeleton of a living person as though it were dissected out and articulated with wires. The detection of the location of a lead bullet accidently embedded in the leg of a person serves to hint at the possibilities of employing this method for locating other physiological abnormalities, such as deep-seated tumors, cysts, cancers, etc., and promises to make the internal structure as visible as the surface.

But the same process has its threatening aspect. If one can photograph through wood and brick walls, and in the dark too, then privacy is impossible ; for it will be light everywhere but to one's eyes, and for these there will be substitutes.

It will be worth the while to say that the sun's light has waves of all lengths, and if such photographic work be possible with such as comes from electrically excited bodies, the same wave-lengths from sunlight can be selected for the same work. The chief difficulty will be to exclude the short rays not wanted.

There does not appear to be any evidence at all, that the waves employed by Röntgen are different from other rays producible in many ways, and one may look for quick development of the possibilities of photographing in what to the eyes is utter darkness.

Self-Paying Electric Light.

Mr. W. H. Preece, in a recent interview reported in a London daily paper, stated that since the electric light was introduced into the General Post Office, the number of days of absence among the employees and officials had been reduced at the rate of two per annum for each one. By calculating the amount of saving represented by these additional days, he finds it to be sufficient to pay for the electric light.

The New Photography.

It has long been known that etheric vibrations other than those producing the sensation of light exist and can be generated by physical means. These vibrations have been found both of longer and shorter wave-lengths than those of white light, and even in this light itself a difference of wave-length exists in the various component colors. The subtle fluid ether, the assumption of which has so successfully explained many puzzling phenomena, seems to readily vibrate to any period in unison with the exciting cause. We may consider the beginning of our real knowledge of etheric waves in the electromagnetic waves of Hertz, which are capable of passing through many substances not ordinarily transparent. They are readily reflected and may be refracted by prisms or collimated by lenses made of substances which are transparent to them.

Prof. Röntgen's experiments have recently been confirmed by Prof. Wright, of Yale, and Prof. Trowbridge, of Harvard College. It is certain that these singular rays exist and will penetrate many substances opaque to light. Glass, one of the most profoundly opaque substances, forms the envelope of the source of them, the Crookes' tube. We should look for very much more satisfactory results with a Crookes' tube with an aluminum window to permit the cathode rays to pass unobstructed. Then it may be possible to produce them with an induction coil and a few cells, which now seems impossible.

In Prof. Trowbridge's experiments at Harvard College he used a sensitive Cramer dry plate and developed with rodinal. The source of cathode rays was a Crookes' tube. An ordinary 60-volt alternating current was used and was sent through the primary of an ordinary induction coil. The resistance of the primary of this coil is .1 of an ohm and of the secondary 6000 ohms, the current through the primary being about 15 amperes. The current from the secondary of the first coil was sent through the primary of a Tesla coil with 25 turns, the secondary having 500 turns. This resulted in a spark through about six inches of air. The terminals were connected with an ordinary spherical Crookes' tube, and the brilliant fluorescent part was used as a source of light. The exposure was two minutes, the tube becoming so hot that it was unsafe to run it longer. All of the photographic effects up to date have been merely shadows. As yet the rays have not been projected by either lenses or mirrors.

Prof. Wright, of Yale, used the Crookes' tube also, and found that a great variety of substances are transparent to the cathode rays. The plate was exposed wrapped in opaque black paper covered with a pine board half an inch thick and was affected by the light from the tube. Pieces of glass were found to be more opaque to these rays than some metals or than ebonite, which is perfectly opaque to luminous rays. Among the metals, aluminum is especially distinguished as transparent. In one of the experiments of Prof. Wright an aluminum medal left an impression upon the plate so clearly as to show both design and lettering. In this latter case, the layer between the medal and sensitive plate was an absolutely opaque sheet of ebonite, such as is used by photographers for plate-holder slides.

In other experiments made by Prof. Wright, a closed paper box containing aluminum grain weights was shadowed upon the plate, the appearance being as though the box were almost transparent and the weights themselves somewhat translucent. An ordinary lead pencil lying near the box showed its graphite core by a darker tracing through the middle of the wood of the pencil. A paper box containing, imbedded in cotton, three spheres, one of platinum, one of brass and the other of aluminum, was shadowed, and the box and the cotton were so transparent as to leave but slight impression on the plate. The brass and platinum spheres intercepted a large portion of the cathode rays, the aluminum a much smaller proportion. A number of American coins, silver, copper and nickel, left strong impressions, showing an almost complete interception of the rays. The copper coins transmitted more than the nickel and the nickel more than the silver. In one experiment, a tracing of Prof. Wright's hand was depicted. The outlines of the hand were somewhat blurred, and in the palm faint traces of the passage of the rays between the bones could be detected, but there was little of the effect reported by Professor Röntgen, of the greater distinctness of the impression made by the bones.

Prof. Wright has also obtained remarkable results on a large variety of substances, taken on an ordinary plate without removing the slides from the plate holder. In England Mr. Campbell Swinton has applied the art to the detection of flaws in metals. The accuracy of the negative is described as marvelous. Photographs of zinc

plates rolled together into a single homogeneous mass have revealed their composite nature by various shadings of their image on the negative. The castings, flaws and blow-holes, which are invisible to the eye, have thus been readily inspected. In medicine the process has been applied to the location of foreign deposits in the body, such as a bullet or calcareous formation. It is notable that the heavy substances, as a whole, are more opaque to these cathode rays than

Drawing from Harvard Photograph.

the light ones, with possibly the exception of lead, which is almost as transparent as aluminum and wood. No two metals are alike, but each shows a different degree of opacity in the photograph made by the rays.

Hitherto it has not been possible without a complicated process to test the uniformity of metal structures, such as gun barrels, iron rails, railway wheels and fly-wheels. It is anticipated that this new photography will shortly revolutionize many branches of the metallic industry, especially in the manufacture of arms. An important experiment made by Mr. Campbell Swinton goes to verify the identity or close relation between the cathode and ultra-violet rays intimated in the first part of this discussion. Plates were exposed shielded by solutions, one of alum in water and the other of iodine in carbon bi-sulphide. The solution of alum is a barrier to the ultra-red or cathode rays, while the solution of iodine in carbon bi-sulphide obstructs the ultra-violet rays. The result of the experiment was the blackening of the plate protected by the alum solution, thus establishing an added similarity between ultra-red and cathode rays. Very little more experiment is needed to definitely place them and establish their wave-lengths.

We give herewith a reproduction of an illustration from the New York *Journal* of Feb. 2, accompanying an article by Prof. Trowbridge, of Harvard, on his experiments, of which the main points are given above, and of another illustration furnished to that newspaper by Prof. Wright, of Yale. We also reproduce from the London *Electrical Review* two engravings of Swinton's shadow photographs. Our London contemporary remarks that in Prof. Röntgen's photograph of the hand, unlike in that of Mr. Swinton, the bones of the hand are shown without a vestige of flesh shadow.

Dr. Pupin, of Columbia College, in an interview with a reporter of the New York *Recorder*, said that "Dr. Röntgen's discovery, to put the whole story in a nutshell, is that the old cathode, or negative pole streamers, known to us for the last 40 years, produce a strong fluorescence in a glass vacuum tube. Dr. Röntgen has discovered that, in addition to the fluorescent light, there is another form of radiations which penetrates all bodies, and casts a reflection or silhouette, varying in distinctness according to the character of the matter through which it passes, upon a sensitive photographic plate, placed beyond the object. What the possibilities of this new discovery may prove to be we cannot yet estimate. I should class it as one of the highest importance."

Prof. Edwin H. Hall, of Harvard University, in the New York *Sun*, sums up the facts concerning Röntgen's phenomena as follows:

(a) That the so-called rays are sent out from the cathode of a vacuum tube, excited by a powerful alternating or rapidly interrupted current of electricity.

(b) That these "rays" act readily through wood and flesh, less readily through metals, except the lightest of metals, aluminum, and hardly at all through ordinary glass.

(c) That the "rays" are not perceptibly reflected or refracted.

(d) That a medium, a solution of iodine, which absorbs the short ultra-violet rays, does not allow the Röntgen influence to pass, and a medium, a solution of alum, which absorbs long waves, does allow the Röntgen influence to pass. This is from Mr. Swinton, an English experimenter.

(e) That the "rays" are not affected by the magnet.

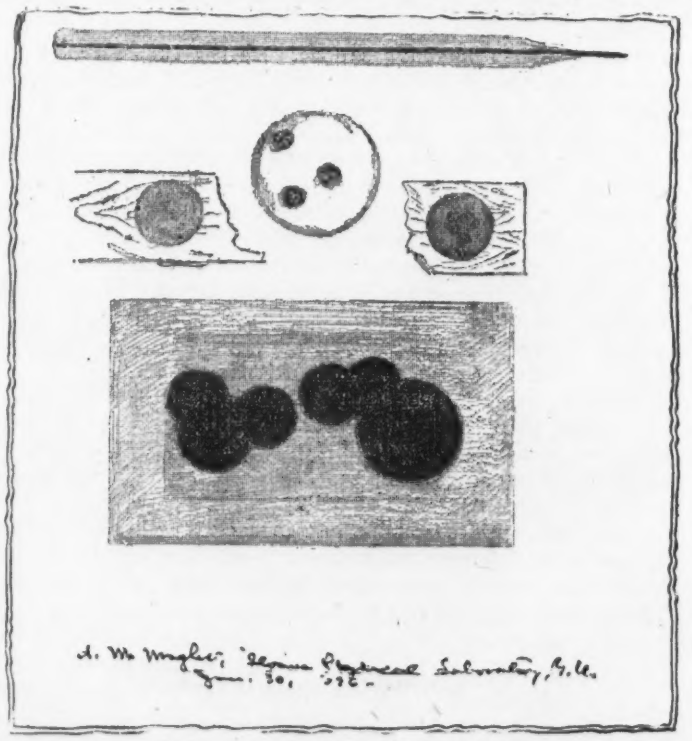
The hypotheses are:

(a) That the "rays" are propagated by vibrations of greater length than those of ordinary light. Against this hypothesis we must put an experiment of Mr. Swinton.

(b) That the "rays" are ultra-violet rays. But ultra-violet rays are called such merely because they are refracted more than the violet rays, which are themselves the most refrangible rays of the visible spectrum. As the Röntgen "rays" are apparently not refracted at all, it is difficult to see how they can be ultra-violet rays.

(c) That they are rays of longitudinal vibration. It is hard to see how they would differ essentially from the electric oscillations, or displacement currents, set up in the space between the plates of an electric condenser, a Leyden jar, for instance, when the charge upon the plates is rapidly reversed. Therefore it seems that we already know something about the behavior of such vibrations, and there seems to be no reason whatever why "rays" propagated by such vibrations should not pass with great readiness through glass. But the Röntgen "rays" act through ordinary glass with great difficulty, and it is very doubtful whether they can be explained by means of longitudinal vibrations.

Prof. Hall asks whether we may consider that the Röntgen effect passes through wood, or flesh, or any other opaque material, in the form of rays at all. Lenard's rays may not be just like Röntgen's, but they appear to have much in common, and the Lenard tube has a little "window" of aluminum as a centre of radiation, not trans-



Drawings from Yale Photograph.

mitting the rays as glass would transmit light, but rather radiating, as if itself the source of the vibrations proceeding from it.

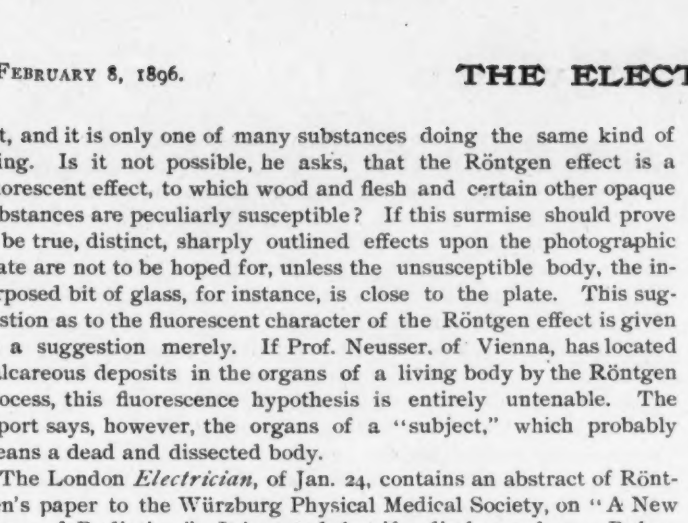
This is the kind of effect observed with fluorescence, when uranium glass, for instance, excited by ultra-violet rays, gives out radiations peculiar to itself, radiations of green light. It does this without being

hot, and it is only one of many substances doing the same kind of thing. Is it not possible, he asks, that the Röntgen effect is a fluorescent effect, to which wood and flesh and certain other opaque substances are peculiarly susceptible? If this surmise should prove to be true, distinct, sharply outlined effects upon the photographic plate are not to be hoped for, unless the unsusceptible body, the interposed bit of glass, for instance, is close to the plate. This suggestion as to the fluorescent character of the Röntgen effect is given as a suggestion merely. If Prof. Neusser, of Vienna, has located calcareous deposits in the organs of a living body by the Röntgen process, this fluorescence hypothesis is entirely untenable. The report says, however, the organs of a "subject," which probably means a dead and dissected body.

The London *Electrician*, of Jan. 24, contains an abstract of Röntgen's paper to the Würzburg Physical Medical Society, on "A New Form of Radiation." It is stated that if a discharge from a Ruhmkorff coil passes through a sufficiently exhausted Lenard, Crookes or similar apparatus, and the tube is covered with a somewhat closely fitting mantle of thin, black cardboard, it is observed that in a completely darkened room a paper screen, washed with barium-platinocyanide, lights up brilliantly and fluoresces equally well, whether the treated side or the other be turned toward the discharge tube. A most striking feature of this phenomenon is that an influence capable of exciting brilliant fluorescence is able to pass through the black cardboard, which transmits none of the ultra-violet rays of the sun or of the electric arc. Other bodies also possess this property. Paper is very transparent, a fluorescent screen held behind a volume of 1000 pages lighting up brightly, printer's ink offering no perceptible obstacle. A single sheet of tinfoil is scarcely noticeable, but several layers cast a shadow. Wood an inch thick or more is but slightly opaque. An aluminum plate three fourths of an inch thick weakens the effect considerably, though it does not entirely destroy the fluorescence. An inch or more of vulcanized rubber lets the rays through. Glass plates of the same thickness behave in a different manner according as they contain lead or not, the former being much less transparent than the latter. Behind plates of copper, silver, lead, gold and platinum fluorescence is still clearly visible, but only when the plates are not too thick. Lead 1-16th of an inch is as good as opaque, and platinum 1-125th of an inch thick is transparent. Silver and copper sheets may be decidedly thicker than the latter. Prof. Röntgen states that it is still an open question whether the chemical effects on the silver salts of photographic plates are exercised directly by the rays, or are due to the fluorescent light which may be generated on the glass plate or perhaps on the layer of gelatine. Experiments were made to determine whether the rays were refractive, but this is very uncertain; even if refraction exists, it is extremely small. Experiments with finely powdered substances proved that refraction and regular reflection do not exist to any noticeable degree, and the rays, therefore, cannot be concentrated by lenses. Prof. Röntgen did not succeed in deflecting the dark rays by a magnet, which up to now has been a characteristic of the cathode ray. He concludes from this and other considerations that the former rays are not identical with cathode rays, but may be generated by the latter at the glass wall of the discharge apparatus.

He does not believe that the new rays are in reality ultra-violet light as they do not possess some of the distinctive characteristics of the latter. In conclusion Prof. Röntgen says that there seems to be some connection between the new rays and light rays in the shadow of pictures, and the fluorescing and chemical activity of both kinds of rays. It has long been known that besides the transverse light vibrations, longitudinal vibrations might take place in ether, and according to the views of different physicists, must take place. Certainly their existence has not up to now been made evident, and their properties have not been on that account experimentally investigated. May not the new rays be due to longitudinal vibrations in the ether? Prof. Röntgen states that he puts more and more faith in this idea and, therefore, announces it, though it requires further corroboration.

The London *Electrician* of Jan. 24 contains an abstract of a paper by G. Jaumann in *Wiedemann's Annalen* for January, in which he adduces arguments to show that cathode rays are longitudinal electric oscillations, although a radial or tangential transversiality may be superposed. The existence of longitudinal electric waves is not admitted by the Maxwell-Hertzian equations, but almost any change whatever made in them, he says, makes their existence possible. It is stated that cathode rays cannot be identical with ultra-violet rays, from which they are distinguished by totally different properties.



SWINTON PHOTOGRAPHS.

The London *Electrical Engineer* reports that on reading of Prof. Röntgen's discovery of photography by Crookes' rays, the German Emperor promptly invited Prof. Röntgen to Potsdam, and the latter gave there a demonstration of the new method. He photographed objects which were placed behind panels of wood, and in wooden and cardboard boxes, the rays which photographed the objects passing through the wood or cardboard. At the conclusion of the experiments the German Emperor invited Prof. Röntgen to supper, and remained with him and other guests conversing about the invention till midnight, when he personally handed Prof. Röntgen the Crown Order, Second Class.

Central-Station Working—VII.

Small Central Stations.

BY IRVING P. LORD.

ELECTRIC lights have become so popular and comparatively cheap that scores of cities with a population of less than 2000 now pride themselves on being lighted by electricity. Being interested in an electric light plant, located in a city of 2800 souls, and having been one of the organizers who placed it in operation some 10 years ago, when the city was less than two thirds its present size, it will be my object to note the result of such experiences as I have had, in the hopes that it may aid in starting other lighting plants in the smaller cities of the United States. The writer is fortunate enough to have his investment in a water-power plant, and as he has never had any experience with engines and boilers, will leave that feature of the discussion to others.

There is a difference in the cost of installing an electric light plant in the year 1896 from what there was in 1885. Dynamos, transformers, lamps, wire and all other things that go to make up a complete system can be purchased at a much lower figure now than then.

Our water-power is a good one, having a capacity of about 200 horse-power. It is never-failing, the head and volume of water varying but little. The wheel used is a James Leffel & Co. 40-inch horizontal Samson. The station is one half mile from the business centre of the city. The building is of frame fully detached, and commands a fire insurance rate of 3 per cent. per annum in the best stock companies.

When the plant was first installed (1886) there was one direct-current incandescent, and one arc-light machine placed in position. The latter was intended for street lighting and commercial purposes, while the former was expected to furnish light for residences, as well as such business places as preferred that system. It was soon demonstrated that a direct-current dynamo was not the most desirable for incandescent lighting. It was impossible to maintain an equal voltage throughout the circuit, as the farthest light was a mile distant from the station, and the result was that the direct current was displaced by a 1500-light Woods alternator. No one could ask for anything better. The voltage taken at the same time at widely different points in the circuit does not vary one volt. It is, therefore, safe to say that if it is desired to furnish lights half a mile, or even less distant, from a station, an alternating-current dynamo should be purchased.

From the arc machine were, and still are, extended two circuits, one for street lighting and the other for commercial use. The commercial lights run every night until 10:30 o'clock, while the street lamps are turned off at 1 o'clock a. m., except on moonlight nights, when they do not burn at all. This plan in small cities will be found serviceable, economical and satisfactory. My experience with arc lighting has been with a Brush machine. It has given good satisfaction to the patrons, and made money for its owners.

One mistake commonly made by those building electric light plants in small cities is in building too small a station, and buying machines of insufficient capacity. They think to economize thereby, but it is only an extravagance. Better have your station and your dynamos 50 per cent. larger than you think you will really need, than just a little too small. Plenty of room inside a station is a boon worth looking after, and an abundance of light and ventilation, together with strict neatness, is imperative to the successful working and longevity of any dynamo.

The hours for operating country plants must be governed largely by the cost of producing the power. With a water-power the cost of running from sundown to sunrise is not much greater than from sundown to midnight or 1 o'clock a. m. We tried the latter schedule for five years, but the demand for residence lights was insignificant during that time. People refused to light their houses with electricity if they were obliged to keep kerosene lamps in every room. (There is no gas plant here.) When we decided to run the incandescent machine all night, an active canvass was made for residence lights. It was successful, and the demand has been steadily increasing. We never had a customer once using the lights in his house take them out and go back to kerosene. Whenever a new house is being erected an active effort is made to have the owner wire for electric lights. Once wired it is much easier to secure the occupant for a customer.

This brings us to the question of wiring in small cities. In some places the wiring is done free of charge, in others regular rates are obtained. We have tried both plans. It now seems that the most desirable way is to wire all buildings, commercial as well as residence, at cost. If you wire free, you will soon have a large amount invested in this item, and the owner of the building, having no investment, is in no hurry to connect the current. If you charge full rates for wiring and fixtures, the item is usually so large that the would-be customer is scared out, and will not wire at all.

What the owners of plants want is business that will return a fair profit, and the all-important question is, How shall we get it? In answer to this I will say: First, give a satisfactory light during such hours as the demand and the income from your plant will warrant. Second, furnish light at such prices as will return a fair revenue upon your investment, figuring, of course, all items of expense, not forgetting depreciation. Third, actively and persistently canvass the business houses as well as residences in your territory. Fourth, wire at the lowest possible figure in order to get your customers started. Fifth, collect your bills monthly and promptly.

One common mistake in the building of country plants is the putting in of too light and poor a class of poles. On the main line the poles should not be less than 35 feet long, with a diameter at the small end of 7 inches and at the opposite end of 12 to 15 inches. Good substantial cross-arms should be used. Iron steps do not cost much and should be used on the main line poles at any event. No poles should be set, or cross-arms attached, without first being painted. As compared with the cost nothing else about the construction of the entire plant will show off to such good advantage.

All poles should be firmly set, and where an angle is made in the line, the corner pole should be securely guyed. This may seem unimportant to some, but if there is any one thing that detracts from the appearance of a plant, it is a slipshod pole line.

In conclusion I will say that there are hundreds of small cities and villages in the United States that to-day are without electric light plants. This should not be. Interest should be awakened and the subject properly presented to the business men of these various places; the result would be the establishment of numerous small plants in every State where to-day the inhabitants are burning the tallow dip and kerosene oil. The sale of electrical goods is bound to more than double in the next few years, and the direct cause of it will be the starting of new plants in the country villages and cities which are now groping in darkness.

The Alternating-Current Arc.

At a recent meeting of the Society of Arts, Boston, Prof. W. L. Puffer read a paper upon the subject of arc lights operated by alternating currents, which was copiously illustrated by lantern slides. Prof. Puffer first threw upon the screen an arc light burned with a direct current. The fact that the positive carbon is by far the hotter of the two, and the form of the flame passing from the positive to the negative carbon, were thus beautifully shown. In an experiment which followed, by means of a rapidly rotating disc through which were cut several slots, an alternating-current arc was made to appear upon the screen at the several different phases of the current. At one moment, the upper carbon was very bright, the flame also indicating that this carbon was the positive electrode. At another time, the openings in the disc came at such periods as to show no flame whatever, with the two carbons only cherry red; and at still another period, the lower carbon was shown to be positive. And so, in more or less rapid succession, the different phases of the light were beautifully shown upon the screen.

The revolving disc was then driven by an alternating-current motor connected in the same circuit with the lamps. By this means the disc was kept in unison with the generator, and the light shown upon the screen continuously in any of the phases desired. Still later, the current was passed between three carbons, each of which was made to show in succession positive and negative, with the flame changing many times from one carbon to another.

How Mayor Pingree Got Left.

Not long ago Mayor Pingree, of Detroit, refused to pay the rental of his telephone in advance. The collector, however, stole a march on his Honor by proceeding to his residence and presenting the bill to Mrs. Pingree. Not knowing that the Mayor contemplated a fight with the Bell monopoly, Mrs. Pingree innocently paid the bill, and now his Honor is awaiting another quarter to roll by in order to get a chance to bring the issue up again.

Past and Present Obstacles in the Storage-Battery Development.*

BY L. EPSTEIN.

It is evident that Mr. Carl Hering, the author of the paper recently read before the American Institute of Electrical Engineers on "Past and Present Obstacles in the Storage-Battery Development," has given much time and thorough attention to the solution of the question how to construct a good accumulator; but many of the hints thrown out, and recommendations made by him, have been anticipated and removed from the field of speculation to the more substantial basis of actual working. In fact, most of the desiderata recommended by him will be found embodied in the accumulators of which the writer of this article is the inventor, and which have now been on the market for several years.

The missionary work which, according to the above-named paper, must first obtain before public confidence will be restored, may apply to the United States; but in this country we can look back with satisfaction upon the missionary work done many years ago, being now in the fortunate position of reaping the results. There exists at the present moment no doubt in the minds of consulting and central-station engineers that an improved Planté type is far superior to any type in which the material is employed as a paste or as a conglomerate.

The "delicate sickly baby" has, in this country at least, long since developed into a strong and healthy youth, promising ere long to attain full maturity, and we may hope to preserve it during a reasonably long lifetime.

The five chief diseases of an accumulator are enumerated as follows:

1. Buckling.
2. Short-circuiting.
3. Sulphating.
4 and 5. Disintegration and dropping out of peroxide.

I quite agree with the author of the paper that it is impossible to prevent buckling by sheer force. This has been attempted over and over again, but has never met with complete success. The only certain way to obviate buckling is to construct the plate in such a manner that it will not occur. The causes of buckling are manifold, the two chief ones being, apart from short circuits, unequal action of either the active material or the supporting grid or frame. In a plate either pasted, or otherwise so constructed that the active parts form comparatively large units as compared with the conducting parts, there will, and must always be, an unequal action, not only of the different slabs contained in one plate, but even of the different parts in one and the same slab. Some will contribute more to the discharge than others, and as a natural consequence, at the end of the useful discharge, not two slabs, nor two parts of one and the same slab will be found in the same electrical and chemical condition. Furthermore, as it is impossible to construct a grid thoroughly uniform, some ribs being originally thinner, or become more peroxidized than others, there will be an unequal flow of electricity in different parts of the grid. Bearing in mind the expansion and contraction consequent upon different stages of charge and discharge, it will become evident at once that, owing to the different density and expansion of the material, something will have to give way, and if it is not the material, it will have to be the frame.

"The ideal method would seem to be a vertical lead plate to act as a good conductor, with an extremely large surface and a thin layer of peroxide on it, thoroughly exposed to a large quantity of acid which is capable of circulating rapidly." This identical method suggested itself to the writer of this article more than five years ago, at which time he could already look back upon 10 years' work and experience in accumulators, assisted by most efficient technical and financial support. His plate, as used in hundreds of installations for all the different purposes to which accumulators are applied, have invariably met with the most complete success, and sometimes under conditions which were very exceptional and most severe. The Epstein plate consists of a vertical web, with an equal number of horizontal ribs on both sides, and the active material is produced out of the substance of the lead itself by chemical and electrical processes without any material being applied to the plate. The active material blends gradually with the original substance of the lead itself, insuring the most perfect contact. Examined under a magnifying glass, it becomes apparent that the active material not only covers the surface, but enters into the plate by a myriad of minute roots. The grooves are not completely filled out, and as the ribs are so constructed that the surface of the plate is increased five-fold, it will at once become apparent that the Epstein plate realizes the anticipations of Mr. Hering with regard to good conductivity, large surface, and a thin layer of peroxide on it.

It has been proved by numerous tests that this plate withstands a treatment that has been found destructive to other types. I refer to tests made by Prof. Ayrton, in which such plates were discharged down to zero, and allowed to rest for considerable periods both after charge and discharge; also to tests made by Messrs. Alabaster, Gatehouse & Co., in which the cells, after standing idle for three months without intermediate charge, were found to have retained 80 per cent. of their original capacity; further, to the tests of Mr. Henry Lea, in which he habitually short-circuited Epstein cells for months by means of a stout copper wire, and many other similar tests and practical experiences, all giving the same results. It was to be expected that the capacity of such a plate could be utilized to much greater advantage than that of a plate in which the active material is present in a more or less thick layer, the surface of the corrugated plate being everywhere freely exposed to the acid. This was fully borne out by the test made by Mr. Swinburne. In his report he lays stress upon the extraordinary constancy of pressure. He expresses himself as follows: "Not the least merit of the Epstein cell is the extraordinary constancy of pressure throughout most of the discharge. When discharged at a normal current, the pressure keeps almost absolutely constant until the cell is entirely discharged."

It is not surprising that the much dreaded formation of an undue amount of sulphate should be absent in this type of plate, as the active material, instead of being present in a comparatively small number of large units, is distributed all over the plate in units which only form a small fraction of one of the former. The active and conducting parts, which can in the pasted plate only work harmoniously if a kind of compromise is arrived at between their divergent interests, work in this plate harmoniously together, and during the different stages of charge and discharge, by reason of a reciprocal give and take, their interests are identical, and they do not tend to part company if one of them is favored at the expense of the other. The assertion that the gradual washing away of the surface of the peroxide, and the slow peroxidization and consequent disintegration of the lead support seem to be absolutely unavoidable is, in the main, correct, the remaining question being only that these two sources of decay should be sufficiently slow as not to militate against the technical usefulness and financial success of the battery. In the Epstein plate, both these influences, although they may be at work, make themselves only very gradually felt. For instance, plates which have been in daily use for two years in a central station were found on examination to look like new, and, on test, to have retained their full original capacity. Mr. Hering's opinion that the only batteries which have an outlook for traction work are those which have a very large surface, very small depth of active material formed electrolytically, can be fully endorsed; while, on the other hand, exception must be taken to the remedy suggested for retaining the effectiveness of the positive plates, consisting in making the frames very thin, and relacing them from time to time, it not being possible to retain the active material in them. This method would only recommend itself as an alternative, but inasmuch as the positive plates of the Epstein type have made on a very trying road more than 12,000 car-miles without any repairs or renewals becoming necessary, it is clear that they are eminently fitted for the work.

In many cases it will be found more advantageous to provide in the car light batteries of small capacity for a few trips in preference to heavier batteries for a greater number of trips. In such cases it will, of course, be indispensable that the small battery should be capable of discharging at high rates. The type manufactured by the Epstein Company for traction purposes allows its being discharged with a fairly good efficiency in one hour, and even less, and thereby enables a very considerable reduction in the weight to be made. The increase in the total weight of an accumulator car with full complement of passengers, as compared with a car driven on the trolley system, need not be more than three per cent. Astonishing as this figure may be found, full proof for its correctness can be adduced.

On the basis of the results which have been enumerated in the foregoing, the writer hopes not to be considered presumptuous if he suggests that a more fitting heading for an article dealing with the present aspect of storage batteries would be "Past Obstacles and Present Successes."

* From the London *Electrical Review*, Jan. 10, 1896.

The Calculation of Alternating-Current Transmission Circuits.

P. M. HELDT.

Various authors have given tables showing the relative amount of conducting material required with the different systems of alternating-current power transmission, but the literature regarding the calculation of alternating-current transmission circuits seems to be scarce, especially in English.* The object of the present article is to compare the alternating system of transmission with the continuous system, to compare the alternating systems among themselves, to deduce equations showing the relation between the various factors involved in alternating-current transmission, and to show the application of the equations by the aid of simple examples.

The factor which generally determines the dimensions of a transmission circuit is the relative loss of power along the line, or the percentage of watt-loss. It is also often of importance that the drop of potential be kept within certain limits, for otherwise there results poor regulation. Now it is well-known that with continuous currents the percentage of watt-loss and the percentage of drop in potential are equal, which is, however, not the case with alternating currents, as will be shown presently.

The angle of phase difference between current and E. M. F. at the generator end is in so far of importance as it determines the output of the generators. Whatever limits this output—heating or armature reaction—depends on the strength of the current, which in turn will be greater, the greater the difference of phase between current and E. M. F. The factors which are generally known in particular cases of transmission are: The power to be transmitted, the percentage of watt-loss, the working potential and the power factor of the load or the cosine of the angle of phase difference between current and E. M. F. at the terminals of the load. The problem then consists in finding the resistance of the line, the drop of potential and the phase difference between current and E. M. F. at the generator terminals in terms of these known factors.

The following symbols will be used throughout the article :

E_1 = working potential of the load plus drop in potential along the line corresponding to working potential.
E_2 = working potential of the load.
I = current of any one phase of the load.
θ_1 and θ_2 = angles of phase difference between E_1 and I and E_2 and I respectively.
W_1 = watts delivered to the line.
W_2 = watts transmitted.
L = watt-loss in line.
p = ratio of watts delivered to the line to watts lost in line.
R = resistance of any conductor attached to one terminal of the generator.

Let us first consider the transmission of power by simple or single-phase alternating currents. All E. M. Fs. and currents will be supposed to be of the sine form. The power transmitted

$$W_2 = E_2 I \cos \theta_2 \qquad (1)$$

and the loss in the line

$$L = 2 R I^2 \qquad (2)$$

If continuous-current were employed to transmit the same power at the same voltage, and percentage of watt-loss, the current required would be $I \cos \theta_2$, and the resistance of the circuit $2 R'$ must be such that

$$2 R' (I \cos \theta_2)^2 = 2 R I^2 \qquad (3)$$

$$R' = \frac{R}{\cos^2 \theta_2} \qquad (4)$$

With the alternating system the weight of the conducting material required will therefore be $\frac{1}{\cos^2 \theta_2}$ times that required with the continuous system.

Fig. 1 shows graphically the conditions of transmission. The

Fig. 1.

current, I, lags behind the impressed E. M. F., E_1, by an angle, θ_1. The drop of potential in the line, $2 R I$, is in opposition of phase to the current, I, and the resultant of E_1 and $2 R I$ constitutes the final E. M. F., E_2.

From the diagram it will be seen that

$$E_1 \cos \theta_1 = E_2 \cos \theta_2 + 2 R I \text{ and} \qquad (5)$$

$$E_1 \sin \theta_1 = E_2 \sin \theta_2. \qquad (6)$$

From these two equations we find that

$$\tan \theta_1 = \frac{E_2 \sin \theta_2}{E_2 \cos \theta_2 + 2 R I} \qquad (7)$$

$$E_1 - E_2 = E_2 \left(\frac{\sin \theta_2}{\sin \theta_1} - 1. \right) \qquad (8)$$

The energy delivered to the line is $E_1 I \cos \theta_1$. We have then

$$p = \frac{W_1}{L} = \frac{E_1 I \cos \theta_1}{2 R I^2} = \frac{E_2 I \cos \theta_2 + 2 R I^2}{2 R I^2} \qquad (9)$$

$$p - 1 = \frac{E_2 \cos \theta_2}{2 R I} \qquad (10)$$

$$R = \frac{E_2 \cos \theta_2}{2 I (p - 1)} \qquad (11)$$

Equations (11) (8) and (7) enable us to determine R, $E_1 - E_2$ and θ_1, when E_2 W_2 θ_2 and p are known. Let it be required to transmit 100,000 watts, at 5 per cent. watt-loss in the line, the working potential of the load being 2000 volts and its power factor .954. Find R, $[E_1 - E_2$ and $\tan \theta$.

The current that will flow is

$$I = \frac{W_2}{E_2 \cos \theta_2} = 52.41 \text{ amperes.}$$

According to equations (11), (8) and (7)

$$R = \frac{2000 \times .954}{2 \times 52.41 \times 19} = .958 \text{ ohm}$$

$$\tan \theta_1 = \frac{2000 \times .3}{2000 \times .954 + 2 \times .958 \times 52.41} = .2988$$

$$E_1 - E_2 = 2000 \left(\frac{.3}{.2862} - 1 \right) = 96.4 \text{ volts.}$$

In cases where the two wires are strung not very near together and the periodicity of the current is comparatively high, the inductive drop of potential is not negligible as compared with the ohmic drop. Let E_1 (Fig. 2) be the voltage impressed at the terminals of a circuit having an inductance coefficient, L. Let n be the periodicity of the

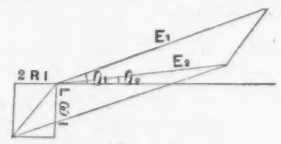


Fig. 2.

current and $w = 2 n n$. The inductive E. M. F., $L w I$ is 90° in advance of the current. According to the diagram

$$E_1 \sin \theta_1 = E_2 \sin \theta_2 + L w I \qquad (12)$$

$$E_1 \cos \theta_1 = E_2 \cos \theta_2 + 2 R I \qquad (13)$$

Dividing the first equation by the last

$$\tan \theta_1 = \frac{E_2 \sin \theta_2 + L w I}{E_2 \cos \theta_2 + 2 R I} \qquad (14)$$

Comparing equations (7) and (14) we see that the inductance increases the phase difference between current and E. M. F. at the generator end, and if E_2 θ_2 and I are fixed, E_1 and $(E_1 - E_2)$ will be increased. The energy lost in the line is

$$I_1 (E_1 \cos \theta_1 - E_2 \cos \theta_2) = 2 R I^2 \qquad (15)$$

or the same as without inductance. Inductance in the line will therefore not change the quantity of energy lost in the line, but increase the drop of potential in the line, and the phase difference between current and E. M. F. at the generator end. From the diagram it also follows that

$$E_1 - E_2 = E_2 \left(\frac{\sin \theta_2}{\sin \theta_1} - 1 \right) + \frac{L w I}{\sin \theta} \qquad (16)$$

We will now calculate what would be the value of $(E_1 - E_2)$ and $\tan \theta_1$, if the circuit in the above problem had an inductance coefficient $L = .01$ henry, and the periodicity of the current $n = 100$. Then $\omega = 628$ and R will be as before .958 ohm.

$$\tan \theta_1 = \frac{2000 \times .3 + (.01 \times 628 \times 52.41)}{2000 \times .954 + (2 \times .958 \times 52.41)} = .4626$$

$$E_1 - E_2 = 2000 \left(\frac{.3}{.42} - 1 \right) + \frac{(.01 \times 628 \times 52.41)}{.42} = 212.3 \text{ volts.}$$

The resultant current at the junction of two or more parallel circuits is not equal to the sum of the currents flowing in these circuits, unless the phases of the currents coincide. Otherwise the resultant

* See Dr. Bell's paper, the "Monocyclic System," read at the Cleveland convention of the National Electric Light Association and reprinted in THE ELECTRICAL WORLD of March 9. Also, Oberingenieur Goerges in *Electrotechnische Zeitschrift*, No. 3, page 47, (1895).

current and the difference of phase between it and its E. M. F. may be found by constructing the polar diagram (Fig. 3). E is the E. M. F. at the junctions of the two parallel circuits of resistance, R_1 and R_2 and inductance L_1 and L_2. The resultant current is I, and

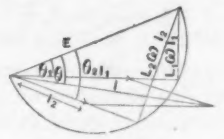


FIG. 3.

θ is the angle by which it lags behind the E. M. F. From the diagram it follows that

$$I = \sqrt{I_1^2 + I_2^2 + 2\, I_1\, I_2 \cos\,(\theta_2 - \theta_1)} \qquad (17)$$

The energy delivered to the circuits must be equal to the sum of the energies dissipated in them, or

$$E\, I \cos\theta = E\, I_1 \cos\theta_1 + E\, I_2 \cos\theta_2 \qquad (18)$$

from which follows that

$$\cos\theta_1 = \frac{I_1 \cos\theta + I_2 \cos\theta_2}{I} \qquad (19)$$

Let it be required to find the current and the angle by which it lags at the junction of two circuits, one circuit supplying a non-inductive load of lamps with a current of 100 amperes, the other circuit containing an induction motor taking a current of 80 amperes at full load with a power factor of the value .844. According to equations (17) and (19)

$$I = \sqrt{100^2 + 80^2 + (2 \times 80 \times 100 \times .844)} = 172.9 \text{ amp.}$$

and

$$\cos\theta = \frac{100 + (80 \times .844)}{172.9} = .968$$

Sometimes a three-wire system is used for distribution circuits similar to the continuous-current three-wire system. In this case the potential difference between the two outside conductors is twice the working voltage $= 2E$. The current corresponding to the same amount of energy is therefore (provided the two circuits are balanced), $\frac{I}{2}$. For the same watt-loss the resistance R^1 of one of the outside conductors is such that

$$2\, R^1 \left(\frac{I^2}{4}\right) = 2\, R\, I^2 \qquad (20)$$

$$R' = 4\, R.$$

The middle or neutral wire is generally taken at one half the size of either of the main conductors, so that the total amount of conducting material required with this system is $\frac{5}{16}$, or 31.25 per cent. of that required with the common system.

In what follows the different alternating-systems will be considered. It will be assumed, as before, that all E. M. Fs. and currents are sinusoidal, and besides that the different phases are equally loaded.

The two-phase four-wire system consists of two circuits carrying simple-alternating currents differing in phase by 90°. The watt-loss in this system is therefore the same as if the two circuits were used in parallel to transmit the same power at the same potential with simple-alternating currents. The equations deduced for the simple-alternating system are directly applicable to the two-phase four-wire system, if one circuit only is considered.

The following example may serve for an illustration: A power of 1,000,000 watts is to be transmitted at 10,000 volts and 10 per cent. watt-loss. What must be the resistance of the line, and what will be the drop of voltage in the line and the difference of phase between current and E. M. F. at the generator end, the power factor of the load being .9684?

The current in one circuit will be

$$\frac{1000000}{2 \times 10000 \times .9684} = 51.63 \text{ amperes,}$$

and substituting in equations (11), (7) and (8) we find

$$R = 10.42 \text{ ohms.}$$

$$\tan\theta_1 = 2318.$$

$$E_1 - E_2 = 1045 \text{ volts.}$$

A saving in conducting material may be effected by combining two of the four wires into one. This common conductor will then have to carry the resultant of two currents I differing in phase by 90°, which resultant is $I\sqrt{2}$. For the same watt-loss, as with four wires, this common conductor must have a resistance R^1 determined by the equation $R^1\ (I\sqrt{2})^2 = 2R\, I^2$ which gives $R^1 = R$, the common conductor must therefore have the same cross-section as either of the conductors which it replaces. Three conductors will only be required instead of four of the same size without increasing the loss in the circuit. This combination effects therefore a saving of 25 per cent.

The current density in the three conductors will, however, not be the same, as two carry a current I and the third a current $I\sqrt{2}$, neither is the conducting material employed to the best advantage, as will be seen from the following considerations: The watt-loss and the total weight of conducting material both want to be a minimum. The latter corresponds to maximum parallel resistance, and hence the distribution of conducting material among the three conductors that gives the greatest economy is that which makes the ratio

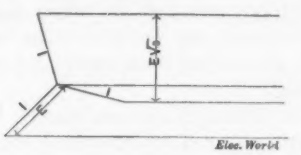


FIG. 4.

of the parallel resistance of the three conductors to the total watt loss a maximum. Let L equal the total watt-loss, R_c the resistance of the common conductor and R_p the parallel resistance of the three wires, then

$$R_p = \frac{R.\, R_c}{2\, R_c + R} \qquad (21)$$

$$L = 2I^2\,(R + R\ ) \qquad (22)$$

$$\frac{R_p}{L} = \frac{R.\, Rc}{2\, I^2\,(2\, R_c^2 + R^2 + 3\, R\, R_c)} \qquad (23)$$

$$\frac{\delta\left(\frac{R_p}{L}\right)}{\delta\,(R_c)} = \frac{R^2 - 2\, R_c^2}{2\, I^2\,(R^2 + 2\, R_c^2\, 3\, R\, R\ )^2} = 0 \qquad (24)$$

$$R_c = \frac{R}{\sqrt{2}} \qquad (25)$$

That is, the common conductor must have a cross-section $\sqrt{2}$ times that of either of the other conductors. This is only a special case of the general truth that the conducting material in any circuit is used to the best advantage if the current density is the same at all points of the circuit.

Again, let R' represent the resistance of one of the ordinary conductors in the three-wire system, and R the resistance of any conductor in the four-wire system, then for equal losses

$$(2+\sqrt{2})\ R'\, I^2 = 4\, R\, I^2$$

$$R' = \frac{4}{(2+\sqrt{2})} R \qquad (26)$$

or the cross-section of one of the ordinary conductors in the three-wire system is to the cross-section of one conductor of the four-wire system, as $(2+\sqrt{2}) : 4$. The total conducting material in the three-wire system is $(2+\sqrt{2})$ times the material in one of the ordinary conductors, but in the four-wire systems the total is four times the material in any one conductor. The ratio of the conducting material required in the two systems is therefore

$$\frac{(2+\sqrt{2})^2}{4^2} = \frac{72.8}{100}$$

The equations of the simple-alternating circuit may be modified so as to give the relations in this circuit.

$$p - 1 = \frac{2\, E_2\, I \cos\theta_2}{(2+\sqrt{2})\, R\, I^2} \qquad (27)$$

$$R = \frac{2\, E_2 \cos\theta_2}{(2+\sqrt{2})\ (p-1)\, I} \qquad (28)$$

The energy delivered to the circuit is equal to the energy transmitted plus the energy dissipated in the circuit.

$$2\, E_1\, I \cos\theta_1 = 2\, E_2\, I \cos\theta_2 + (2 + 1\sqrt{2})\, R\, I^2 \qquad (29)$$

If the line has no inductance the component of the E. M. F. at right angles to the current must be the same at both ends of the circuit.

$$E_1 \sin\theta_1 = E_2 \sin\theta_2 \qquad (30)$$

From equations (29) and (30) may be found the value of $\tan\theta_1$ and $E_1 - E_2$

$$\tan\theta_1 \text{ *} = \frac{E_2 \sin\theta_2}{E_2\cos\theta_2 + \left(\frac{2+\sqrt{2}}{2}\right) R\,I^2} \qquad (31)$$

$$E_1 - E_2 = E_2\left(\frac{\sin\theta_2}{\sin\theta_1} - 1\right) \qquad (32)$$

Among other two-phase systems possible may be mentioned a double three-wire system, which, like the single-phase three-wire system, would require 31.25 per cent. of the conducting material of the ordinary one or two-phase systems, and a double three-wire system, with two of the outside conductors combined into one. The conducting material required with this system would be $\left(\frac{2+\sqrt{2}}{4}\right)\left(\frac{3+\sqrt{2}}{16}\right) = \frac{23.6}{100}$ times the conducting material in the ordinary systems.

Here the two neutral conductors are taken equivalent to one outside conductor. Owing to the complications arising from the multitude of circuits it seems that these systems have not yet been employed to any extent.

In low-pressure distribution circuits the E. M. F. to be employed is determined by the apparatus fed by the circuit, while in high-voltage transmission circuits the voltage, and consequently the economy of transmission, is limited by the stress on the insulation which is proportional to the maximum difference of potential between any two conductors. It will at once be seen that for high-voltage transmission all systems with a neutral middle conductor are out of question as the neutral wire is simply extra.

In the two-phase three-wire system the E. M. F. between the two conductors not connected with each other is $E\sqrt{2}$. To reduce the stress on the insulation to that occurring in the two-phase four-wire system the working potential has to be reduced in the ratio $\frac{1}{\sqrt{2}}$. The current giving the same power will be $I\sqrt{2}$. For equal losses we have

$$R^1(\sqrt{2}\,I)^2 = R\,I^2. \qquad (33)$$

The ratio of the conducting material required with the three-wire system to that required with the four-wire system is therefore twice as large if the maximum stress on the insulation is the same in the two systems as if the working potential is the same. For the latter case we found this ratio to be $\frac{72.8}{100}$, for the former it is therefore $\frac{145.6}{100}$.

The diagram Fig. 4 shows a three-phase circuit with triangle

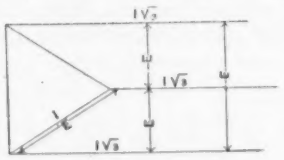


Fig. 5.

connection. The current in any line is $I\sqrt{3}$, and the total watt-loss $3R(I\sqrt{3})^2 = 9RI^2$, while the energy transmitted is $3EI\cos\theta_2$. To transmit this same energy with simple-alternating currents under the same conditions the resistance R' of one line of the simple-alternating circuit is given by the equation

$$2R'(3I)^2 = 9RI^2. \qquad (34)$$

R^1 is one half of R, or the cross-section of one conductor in the simple-alternating circuit is twice the cross-section of one three-phase conductor, and, as in the former case, two in the latter three conductors are required. The ratio of the total conducting material required is 4/3. With the three-phase three-wire system, 25 per cent. of conducting material can thus be saved.

The loss in the line is the difference between the energy delivered to the line and the energy transmitted.

$$3E_1 L\cos\theta_1 = 3E_2 I\cos\theta_2 + 9RI^2 \qquad (35)$$

The ratio of the energy transmitted to the loss in the circuit

$$(p-1) = \frac{3E_2 I\cos\theta_2}{9RI^2} \qquad (36)$$

Hence

$$R = \frac{E_2\cos\theta_2}{3I(p-1)} \qquad (37)$$

*Here θ_1 is an angle of lag for one current and an angle of lead for the other. This does, however, not change the drop in potential nor the effect of the value of θ_1 on the generator output. See M. J. Rodet in *L'Industrie Electrique*, No. 87, page 331.

Where the line has no inductance

$$E_1\sin\theta_1 = E_2\sin\theta_2 \qquad (38)$$

Where each line has an inductance coefficient L and ω represents $2n$ times the periodicity

$$3E_1 I\sin\theta_1 = 3E_2 I\sin\theta_2 + 3L\omega(I\sqrt{3})^2$$

$$E_1\sin\theta_1 = E_2\sin\theta_2 + L\omega I \qquad (39)$$

The inductance coefficient L shall be defined as $\frac{1}{10^8}$ times the $\sqrt{\text{mean square}}$ number of lines of force embraced by any two conductors of the system when a virtual current of one ampere flows in each conductor. The value of L depends on the relative position of the three-line wires and will only be the same for all three-lines where each wire is at the same distance from each of the other two.

From equation (38) it follows that

$$E_1 - E_2 = E_2\left(\frac{\sin\theta_2}{\sin\theta_1} - 1\right) \qquad (40)$$

and from equation (39)

$$E_1 - E_2 = E_2\left(\frac{\sin\theta_2}{\sin\theta_1} - 1\right) + \frac{3Lw\,I}{\sin\theta_1}. \qquad (41)$$

From equations (35) and (38)

$$\tan\theta_1 = \frac{E_2\sin\theta_2}{E\,2\cos\theta_2 + 3RI} \qquad (42)$$

and from equations (35) and (39)

$$\tan\theta_1 = \frac{E_2\sin\theta_2 + 3Lw\,I}{E_2\cos\theta_2 + 3RI} \qquad (43)$$

A power of 500,000 watts is to be transmitted by means of the three-phase three-wire system at a final pressure of 5000 volts and a watt-loss of 8 per cent. The power factor of the load is .95. What will be the resistance of the line, the drop in voltage and the phase difference between current and E. M. F. at the generator end?

The current

$$I = \frac{500{,}000}{3.5000 \times .95} = 35.09 \text{ amperes}$$

and substituting in equations (37) (42) and (40) we find

$$R = 3.924 \text{ ohms}$$
$$\tan\theta_1 = .3024$$
$$E - E = 392 \text{ volts}$$

In the three-phase four-wire system the three main conductors are connected star fashion, and the neutral point is connected with the neutral point of the generator by a wire which will be taken at one half the size of either main conductor. The energy transmitted by the circuit is in this case $3E_2 I\cos\theta_2$, and the loss in the line $3RI^2$. To transmit the same amount of energy by simple-alternating current under equal conditions, the resistance R^1 of one line of the simple-alternating circuit would be such as to satisfy the equation

$$2R^1(3I)^2 = 3RI^2 \qquad (44)$$

from which it follows that

$$R^1 = R/6 \qquad (45)$$

The ratio of the conducting material required in the two systems is then

$$\frac{3\frac{1}{2}}{2\times 6} = \frac{29.2}{100}$$

For high-pressure transmission the conductors have to be three times as large relatively as the potential difference between any two line wires is $E\sqrt{3}$. Where the circuit supplies three-phase

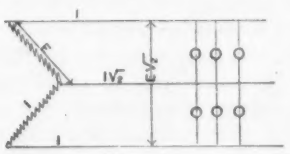


Fig. 6.

transformers the neutral conductor is not needed, and the conducting material will then be 75 per cent. of that required in an equivalent single-phase circuit. In this system the following relations hold good:

$$I = \frac{W_2}{3E_2\cos\theta_2} \qquad (46)$$

$$R = \frac{E_2\cos\theta_2}{I(p-1)} \qquad (47)$$

$$3E_1 I\cos\theta = 3E_2 I\cos\theta_2 + 3RI^2 \qquad (48)$$

Also for non-inductive circuits

$$E_1\sin\theta_1 = E_2\sin\theta_2 \qquad (49)$$

and for inductive circuits

$$3E_1 I\sin\theta = 3E_2 I\sin\theta_2 + 3L\omega I^2 \qquad (50)$$

Equations (49) and (50) give the drop of potential for non-inductive and inductive circuits respectively, as:

$$E_1 - E_2 = E_2\left(\frac{\sin\theta_2}{\sin\theta_1} - 1\right) \qquad (51)$$

and

$$E_1 - E_2 = E_2\left(\frac{\sin\theta_2}{\sin\theta_1} - 1\right) + \frac{L\,\omega\,I}{\sin\theta} \qquad (52)$$

From equations (48) and (49) and (48) and (50) we find:

$$\tan\theta_1 = \frac{E_2 \sin\theta_2}{E_2\cos\theta_2 + R\,I} \qquad (53)$$

and

$$\tan\theta_2 = \frac{E_2\sin\theta_2 + L\,\omega\,I}{E_2\cos\theta_2 + R\,I} \qquad (54)$$

The two three-phase systems may both be converted into three-fold three-wire systems by adding three neutral conductors. The three-wire system would then require 28.125 per cent., and the four-wire system, 8.85 per cent. or 10.42 per cent., the conducting material of the ordinary single-phase system.

Unit Systems and Dimensions.*

BY T. PROCTOR HALL.

The C. G. S. system is based upon three fundamental and arbitrary units, the centimetre, the gram and the second. Other units of length and mass are derived from these by multiples which are integral powers of 10. Other units of time are defined by the old table, "60 seconds make a minute," etc. Units of other physical quantities (velocity, force, work, etc.) are related to the fundamental units by natural laws; and the dependence of the derived units upon the fundamental units constitute the dimensions of the former.

In the metric system the unit of mass, the gram, is made to depend upon the unit of length, the metre, by means of the earth's attraction for water under given conditions. In the C. G. S. system this relation is disregarded and the units of mass and length are defined independently. The relation thus disregarded is not entirely satisfactory for a scientific system, since it holds for only one of the many kinds of matter measured by the unit of mass. A relation which, by definition, fixes the value of a unit should, if possible, apply to all quantities to be measured by that unit. The law of gravitation most nearly satisfies this condition. With its aid a system can be constructed having only two fundamental units, the centimetre and the second.

The units of the centimetre-second system are as follows:

Unit of length, l, one centimetre.
" time, t, one second.
" velocity, v, one cm. per sec.
$v = l/t$.
" acceleration a, unit velocity per sec.
$a = v/t = l/t^2$.
" mass, m, that mass which by its gravitation produces at unit distance unit acceleration.
$m = a\,l^2 = l^3/t^2$. $(\because a \propto m/l^2)$
" force, f, that force which gives to unit mass unit acceleration.
$f = ma = l^4/t^4$.

All other units may be derived from these, as in the C. G. S. system.

It is not necessary to take even two arbitrary units. Ether waves have a constant velocity, or, if there be any variation at all, waves of a particular length have a constant velocity. In other words, in ether waves we have a fixed natural relation between length and time, so that the unit of time may be derived from the unit of length. A single-unit system (centimetre system) may then be constructed as follows:

Unit of length, l, one centimetre.
" time, t, the time taken by ether waves whose length is one centimetre to advance one centimetre.
$t = l$
" velocity, v, one centimetre in unit time.
$v = l/t = 1$.

The remaining units may now be derived as in the C. S. system.

In the single-unit system the dimensions of derived units reduce to order and simplicity. Units in the electrostatic system have the same dimensions as in the electromagnetic system. Corresponding quantities in mechanics, electricity and magnetism have the same dimensions. The system also avoids the false suggestion, which appears explicitly in some of our text-books, that there is something distinctive or peculiar about the fundamental C. G. S. units or about the number three in nature. Any one of the derived units whose dimension is L may be taken as the absolute unit, without making any change in the system.

In order to make use of this system in the theory of dimensions it is not necessary to change the magnitude of our practical units, but only to change the definitions of a few theoretical units and to relate the practical units to the theoretical by multipliers consisting of integral powers of 10, v, and m; where v is the velocity of light in the ether, expressed in centimetres per second (approximately $v = 3.10^{10}$), and m is the square root of the number of grams of matter required to produce at unit distance an acceleration of one centimetre per second (approximately $m = 3930$).

Following is a table showing the dimensions of some common units in the three systems. The last column gives the multipliers which convert C. G. S. into C. units.

Mechanical Units.				Multiplier.
Length	L	L	L	1
Surface	L^2	L^2	L^2	1
Volume	L^3	L^3	L^3	1
Time	T	T	L	$1/v$
Velocity	$L\ T^{-1}$	$L\ T^{-1}$	1	v
Acceleration	$L\ T^{-2}$	$L\ T^{-2}$	L^{-1}	v^2
Mass	M	$L^3\ T^{-2}$	L	$v^2\ m^2$
Surface Density	$M\ L^{-2}$	$L\ T^{-2}$	L^{-1}	$v^2\ m^2$
Volume Density	$M\ L^{-3}$	T^{-2}	L^{-2}	$v^2\ m^2$
Momentum	$M\ L\ T^{-1}$	$L^4\ T^{-3}$	L	$v^3\ m^2$
Force	$M\ L\ T^{-2}$	$L^4\ T^{-4}$	1	$v^4\ m^2$
Moment of Force	$M\ L^2\ T^{-2}$	$L^5\ T^{-4}$	L	$v^4\ m^2$
Stress	$M\ L^{-1}\ T^{-2}$	$L^3\ T^{-4}$	L^{-1}	$v^4\ m^2$
Work	$M\ L^2\ T^{-2}$	$L^5\ T^{-4}$	L	$v^4\ m^2$
Activity	$M\ L^2\ T^{-3}$	$L^5\ T^{-5}$	1	$v^5\ m^2$

Electrostatic Units.				Multiplier.
Quantity of Electricity	$L^{\frac{3}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L^3\ T^{-2}$	L	$v^2\ m$
Surface Density	$L^{-\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L\ T^{-2}$	L^{-1}	$v^2\ m$
Electrical Potential	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L^2\ T^{-2}$	1	$v^2\ m$
Inductive Power	1	1	1	1
Capacity	L	L	L	1
Current	$L^{\frac{3}{2}}\ M^{\frac{1}{2}}\ T^{-2}$	$L^3\ T^{-3}$	1	$v^3\ m$
Resistance	$L^{-1}\ T$	$L^{-1}\ T$	1	$1/v$
Electrical Intensity	$L^{-\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L\ T^{-2}$	L^{-1}	$v^3\ m$
Strength of Pole	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}$	$L^3\ T^{-1}$	L	$v\ m$
Surface Density of Mag.	$L^{-\frac{1}{2}}\ M^{\frac{1}{2}}$	T^{-1}	L^{-1}	$v\ m$
Magnetic Potential	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-2}$	$L^3\ T^{-3}$	1	$v^3\ m$
Intensity of Field	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-2}$	$L^3\ T^{-3}$	L^{-1}	$v^3\ m$
Reluctance	$L\ T^{-2}$	$L\ T^{-2}$	L^{-1}	v^2

Electromagnetic Units.				Multiplier.
Quantity of Electricity	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}$	$L^2\ T^{-1}$	L	$v\ m$
Surface Density	$L^{-\frac{1}{2}}\ M^{\frac{1}{2}}$	T^{-1}	L^{-1}	$v\ m$
Electrical Potential	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-2}$	$L^2\ T^{-2}$	1	$v^2\ m$
Inductive Power	$L^{-2}\ T^2$	$L^{-2}\ T^2$	1	$1/v^2$
Capacity	$L^{-1}\ T^2$	$L^{-1}\ T^2$	L	$1/v^2$
Current	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L^2\ T^{-2}$	1	$v^2\ m$
Resistance	$L\ T^{-1}$	$L\ T^{-1}$	1	v
Electrical Intensity	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-2}$	$L^2\ T^{-2}$	L^{-1}	$v^2\ m$
Strength of Pole	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L^2\ T^{-2}$	L	$v^2\ m$
Surface Density	$L^{-\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L\ T^{-2}$	L^{-1}	$v^2\ m$
Magnetic Potential	$L^{\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L^2\ T^{-2}$	1	$v^2\ m$
Intensity of Field	$L^{-\frac{1}{2}}\ M^{\frac{1}{2}}\ T^{-1}$	$L\ T^{-2}$	L^{-1}	$v^2\ m$
Reluctance	L^{-1}	L^{-1}	L^{-1}	1

A Short but Active Life.

La Nature contains a short note in which the horse-power of a cannon is calculated. An Italian cannon of 100 tons with a charge of 550 pounds of powder and a shot weighing about 2000 pounds, will give an initial velocity of 523 metres per second; the length of time during which the powder acts is less than one hundredth of a second, from which it follows that the horse-power developed is about 17,000,000. The writer adds that after about 100 shots the cannon is put out of service and its total active life is therefore only one second! In large modern cannon the horse-power runs as high as 24,000,000. If the writer had carried out these calculations still farther, he would have found that, after all, this 24,000,000 horse-power does not represent a large amount of energy, as it would be just sufficient to run 31 incandescent lamps for only one day.

* A paper read before the Iowa Academy of Science, Jan. 1, 1895.

"Dynamo-Electric Machinery," By Silvanus P. Thompson—Fifth Edition.—Some Corrections.

To the Editor of The Electrical World:

Sir:—Prof. Thompson made a serious blunder in the fourth edition of his work, which has not been corrected in the fifth. He states virtually that the heating value of a current is proportional to the current and not to its square. In the fifth edition this occurs on page 554, in the discussion of the principles of alternate currents; the passage reads:

"Now the mean of the squares of the sine (taken over either one quadrant or a whole circle) is ½; hence the square-root-of-mean-square value of the sine functions is got by multiplying their maximum value $1 \div \sqrt{2}$, or by 0.707. But the arithmetical mean of the values of the sine is 0.637. Hence an alternating current, if it obey the sine law, will produce a heating effect greater than that of a steady current of the same average strength, by the ratio of 0.707 to 0.637; *i. e.*, about 1.1 times greater."

The heating effect is, of course, in the square of this ratio, or 1.21 times greater.

On pages 156-7, in the fifth edition (the same occur in the fourth), are formulas for permeance; the quantity is defined by equations,

$$1/2\ (A_1 + A_2) \div d. \qquad (1)$$

$$a/\pi \text{ hyp. } \log d_2/d_1. \qquad (2)$$

$$a/\pi \text{ hyp. } \log \left(1 + \frac{\pi (d_2 - d_1)}{d_1}\right) \qquad (3)$$

These are for centimetres; changing to inches and common logarithms they become

$$\frac{2.54}{2}\ (A''_1 + A''_2) \div d'' = 1.27\ (A''_1 + A''_2) \div d'' \qquad (1)$$

$$\frac{2.54}{\pi} \times 2.30 \log_{10} d''_2/d''_1 = 1.86 \log_{10} d''_2/d''_1 \qquad (2)$$

On page 156 the constants are given, 1.596 and 2.274 respectively; the author has called permeance, in making these changes, the ratio of flux divided by ampere-turns, instead of flux divided by magneto-motive force; he has thus introduced a $4\pi/10$ without any explanation, and used a wrong expression for permeance.

In formulas (2) and (3) the author has done the same, and in addition to this looseness has made a numerical error:

$$\frac{2.54}{\pi} \times 2.30 = 1.86;$$

this is the correct constant; but $1.86 \times 4\pi/10 = 2.344$ and not 2.274.

Further on, pages 534–5, the author gives dimensions and data of Sprague stationary motors under the caption, "Modern Forms of Continuous-Current Motors." These motors are not modern, as the manufacture has been discontinued for the last three years; the blue print that this is taken from is dated January, 1890. Moreover, even the best friends of these motors would not claim that their design was such as to entitle them to a place in a book on modern electric machinery, save as an illustration of what should be avoided.

New York. Cary T. Hutchinson.

Japanese Pole Ladder.

To the Editor of The Electrical World:

Sir:—In The Electrical World of Jan. 11, I observe an illustration of a Japanese pole ladder, and with your permission I will translate the article which appeared in connection with it in the *Electrical Friend*, in order that those of your readers who are swimming in the current of electricity may have more light on the subject.

The extension ladder illustrated, which was contrived by Prof. S. Kanda, weighs 1500 mĕ, and is entirely constructed of hard oak. The length of the ladder varies from 2 ken to 3 ken (11.88 to 17.82 feet) when extended, and only 2 shiyaka (1.98 feet) when folded up. The thickness of the same is 2½ sün (about 3 inches) and the width 1 shiyaka (about 11.88 inches).

The whole ladder could be put in a box of 500 cubic sün (one sün being 1.2 inches approximately). At the top of the ladder there are two iron hooks which take hold in the grooves of the cross piece of a line pole. In spite of its higher price the extension ladder has an advantage from the fact that it is not only easily movable from place to place, but is 10 times more durable than the ordinary Japanese ladder made of bamboo.

Lawrence, Kan. Mamoru Jio.

Fly-Wheel Accidents.

To the Editor of The Electrical World:

Sir:—The writer of the article entitled "Fly-Wheel Accidents," appearing in your issue of Jan. 18, does not seem to have taken into consideration one or two very important points in the parallel-running of compound-wound dynamos. In the first place, he has not considered the influence of the equalizer in the case of one of the dynamos running as a motor. A glance at the accompanying sketch and a moment's thought will show him that the amount of current which will pass through the series coil, in the event of the dynamo running as a motor, would be so small as to be negligible. The preceding statement is true with no load on the dynamos. With a load on the system, there would actually be current passing through the series coil to strengthen the field, unless the equalizer is very poorly installed, *i. e.*, where the equalizer is of comparatively high resistance.

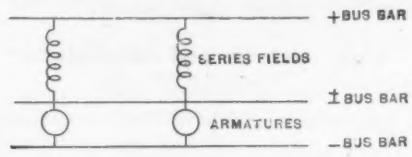


Diagram of Connections.

Again, the dynamos will be running with a forward lead on the brushes. With this condition the armature reaction of a current, tending to run the dynamo as a motor, will *strengthen* the field, and consequently tend to slow down a runaway dynamo. If he doubt this statement let him consider that while running as a dynamo with a forward brush lead, armature reaction *demagnetizes* the field. Consequently a reversed or motor current will *magnetize* the fields.

With these considerations in view I fear the writer of the above-mentioned article will have to look elsewhere for a cause for fly-wheel accidents.

Niagara Falls, N. Y. Paul M. Lincoln.

Electrically Operated Turrets.

To the Editor of The Electrical World:

Sir:—We have just read in your issue of Dec. 28, 1895, page 700, a note on "Electrically Operated Turrets," based upon an article in London *Engineering* of Dec. 6, 1895, which states that the Canet system for the electrical control of turrets is largely employed in the French navy. Permit us to correct this statement, which is inexact. The system of electrical control which has been adopted in France for all of its war vessels, with the exception of two, is the relay system, designed by ourselves and two engineers of the Société des Forges and Chantiers de la Mediteranee, and known as the Sautter-Harlé & Cie, Savatier & De Lagabbe system. It has been adopted, as before stated, for almost all the war vessels of the French navy, notably for the *Jaureguiberry*, the *Entrecasteaux*, the *Saint Louis*, the *Charlemagne* and the *Gaulois*, to the exclusion of the Canet system, which had previously been installed on the *Latouche-Treville*.

Paris, France. Sautter-Harlé & Co.

Uses of Telephones.

The morning after the *St. Paul* ran aground off Long Branch, a cable was carried to the ship, and telephonic communication thus established.

The Chicago publisher, Mr. A. C. McClurg, several months ago, while suffering from some affection of the head, sent a telegram to a New York specialist, offering a very large fee for him to come to Chicago, but the answer was that he could not come at any price, as he had patients whom it was impossible to leave. Mr. McClurg then asked if he could treat him by telephone, and upon receipt of an affirmative answer, a conversation, lasting for more than an hour, was held over the telephone. The symptoms were described, and a method of treatment prescribed, which resulted favorably, the health of the patient becoming so improved that he was able to visit the doctor personally in New York after a short time.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Commutatorless Dynamos. WHITCHER. Lond. *Elec. Eng.*, Jan. 17.—Referring to the (inoperative) method proposed by Malagoli (*Digest*, Feb. 9, 23 and March 16, 1895) for a continuous-current dynamo without a commutator, he describes experiments made by him some years ago, which demonstrated conclusively the utter futility, not to say nonsense, of the idea. If an alternator field is excited by an alternating current, the current induced is often thought to be a continuous one, but as a matter of fact it is an alternating one of double the number of alternations. He describes and illustrates his model, which consisted essentially of a field frame like an ordinary continuous-current machine, exciting the coils as usual, coils wound around the pole-pieces, and an armature consisting of discs of iron having very long teeth ; it was thought that a direct current might be induced in the coils around the pole-pieces, but the result was negative.

LIGHTS AND LIGHTING.

New Incandescent Lamp. Elek. Anz., Jan. 16 ; abstracted from the *Chem. Ztg.*—It consists of a small plate connected to two platinum wires and contained in an exhausted bulb ; it is made of hygroscopic asbestos paste, which, after being prepared in the form of a paper 0.3 mm thick, is cut into strips 6 cm wide and impregnated with a 30 per cent. solution of platinum chloride, then passed through a saturated solution of sal-ammoniac, after which it is dried in hot air and then heated in a Bunsen flame, which converts the platinum solution into a platinum sponge ; this is impregnated with a 20 per cent. solution of magnesium chloride and heated, which process is repeated until the plate is covered with a uniform coating of magnesia ; it is finally dipped into a 10 per cent. solution of cerite nitrate. The magnesia coating protects the platinum ; as the light-radiating properties of the alkalies and the cerite metals is three times that of carbon, it is thought possible that such lamps will take less current ; its electrical resistance is much higher than that of carbon, and the radiating surface can therefore be made much greater. No further information is given.

Determining the Life of a Lamp. Lond. *Elec. Eng.*, Jan. 17.—In a reprint of an interview from a daily paper it is stated that Mr. Preece will shortly enable the users of incandescent lamps to determine in the course of an hour the probable longevity of any lamp; at present there is no such guide. No further information is given.

Cost of Incandescent Lighting from Central Stations. MARKS. *Elec. Eng.*, Jan. 29.—A reprint in full of a recent report to Mr. Edison in order to show what advantages there would be in using 16-cp lamps of 20 to the hp. The first part is a summary of the working of the Philadelphia station for the past year. To attempt to deduce the cost of lighting from small stations is apt to lead to error, because many factors do not appear in small plants which are of great importance in large ones; after running about three years the constant renewals and repairs to the machinery form a considerable item of cost. The average number of lamps connected during the year from July, 1894, to July, 1895, was 89,359; the income per lamp attached was $4.60; the income per lamp-hour, of 0.447 ampere-hour sold, was 0.656 ct. He divides the expenses into a fixed annual charge per lamp, and proportional charges; the latter include oil, waste, packing, lamp renewals and coal, together with all expenses connected with the coal and repairs of boilers; all the other expenses he classes among the fixed charges; the average fixed charges per lamp attached is $1.46 per year, while the average of the proportional charges per lamp-hour sold is 0.1405 ct.; the average burning of a lamp per year is 701.7 hours; the average cost of lamp per year, proportional charge, is 98.6 cts. ; the profit on each lamp per year is therefore $2.13; reducing these figures to lamp-hours, the income from each lamp per hour was 0.656 ct., the fixed charges 0.21, the proportional charges 0.14, leaving a profit of 0.306 ct. He shows from this the proper method of increasing the profit of that station, making several estimates in which he points out the advantages of long hours of use, for which great concessions could be made, giving a table of discounts that might be allowed. All this is on the basis of a 50-watt 16-cp lamp, and is followed by deductions for the 37.5 watt-lamp.

Economical Results in Modern Isolated Arc Lighting. DRAKE. *Elec. Eng.*, Jan. 29.—He gives the results of carefully kept accounts of a large private plant, in order to show what might be done with modern machinery if properly installed. The plant consists of five arc dynamos of 40 lights each, 205 arc lights and a 200-light direct-current dynamo; the plant has been running for over four years; in the summary 10 incandescents are considered an equivalent of one arc. The cost per kw was $0.3145; the three chief items of expense are $13.79 for labor, $9.71 for fuel and $2.75 for carbon, per lamp year, which figures he considers quite phenomenal; during the past year the repairs on the dynamos, including the brushes, amounted to $5.14 per machine; for each lamp it was 42 cents, covering all globe breakages; the total cost per lamp per year was $32.56.

The Ideal Artificial Light. ELIHU THOMSON. *Elec. Eng.*, Jan. 29.—He refers to the recent article of Dr. Birchmore (*Digest*, Jan. 11), comments favorably on it and adds some suggestions. He considers that in some of his work Birchmore simply formulated what had been the common experience, and has been the growing experience, of the past 10 years, namely, that visibility depends on the light which is being reflected having the same wave lengths as that which is used for illumination. He thinks it has been well known that the closing of the iris is due not simply to the rays proceeding from the object viewed, but to the total rays which are transmitted, whether they are used or not; bright sunlight does not necessarily conduce to sharpness and clearness of vision, objects being even more readily distinguished in the shade, especially when tints are to be compared. Dr. Birchmore found that violet light has much greater power in closing the iris than ordinary or yellow light; if this can be confirmed by further investigation, Thomson believes it will undoubtedly be of the greatest importance to make use of means for absorbing the higher rays of the spectrum or those which without contributing much actual illumination still have a great power of affecting the iris. If it is true that the incandescent light is rich in violet rays, then it would be a matter of great importance to apply the proper absorptive screens for such rays; this would apply to every kind of light which has the higher rays in undue proportion; he looks with interest to further developments, but says it is difficult to see why the incandescent lamp should have so large a proportion of the violet rays at the temperature at which it is usually run.

Niobium Incandescent Lamp. Elec. Eng., Jan. 29.—A brief, illustrated description of the method of making these filaments. The incandescent conductor is made of such refractory metals as niobium, tantalum, molybdenum, titanium, zirconium and other metals of that group; a base or support (apparently a carbon filament) is heated in the vapor of a volatile halogen compound of the element which is to be deposited, in a vessel containing hydrogen or similar reducing gas. The ore of the metal to be treated, as, for instance, columbite, has the oxides separated out and is mixed with charcoal and heated to a high temperature in a current of chlorine or bromine or hydrogen, the filament itself being heated by a current, when the metal will be deposited in a pure form on the filament; such a lamp has been run on a test for some months past and is said to show very high efficiency and long life.

POWER AND HEAT.

Acetylene for Power Purposes. Lond. *Elec.*, Jan. 17.—Dr. Frank is quoted as showing that solid calcium carbide would be a cheap and convenient method for the transmission of energy from a waterfall or other cheap source; for 1000 hp for 25 days, 295 tons would be required as against 413 tons of coal. Editorially it is thought that the comparison is incomplete, as no costs are given, and the possibility of using coal in a gas engine instead of steam engine is not considered; to make the comparison complete the editorial states that 267 tons of coal will be required for gas power and 274 of petroleum for oil engines as the dynamical equivalent of 295 tons of calcium carbide.

TRACTION.

Leeds. HOPKINSON'S Report. Lond. *Elec. Rev.* and *Elec. Eng.*, Jan 17.—A reprint of the report of the proposed extensions of the electric railways in Leeds. Most of it is of local interest only ; he recommends a speed of seven miles an hour, including stoppages ; centre poles instead of wires stretched across the street ; as a considerable portion of the distance is through the city, he recommends using the Westinghouse (surface contact) system on those portions, in combination with the overhead system for the rest of the line. He recommends 500 volts, which he does not consider dangerous. Regarding the effect on gas pipes, telegraphs, etc., he recommends that the Board of Trade conditions should be more than fulfilled, which can readily be done. He shows that there would be no gain in using refuse destructors and that ordinary boilers heated by coal would be preferable. In discussing the power required for the cars he shows that it would be of advantage to use stationary accumulator plants, chiefly at or near the ends of the lines, to supply the excessive

current for large momentary demands; these accumulators will be charged with a practically constant current, and will supply two thirds of the momentary excessive demands; they would not require the constant attendance of a man, but would be automatic in action; they have been used with very great advantage in the very successful line from Douglas to Laxey, on the Isle of Man; he recommends an additional plant of accumulators near the station; when accumulators are used at the end of the line it is only necessary to provide return conductors sufficient to carry the average return current with less than 7.5 volts; if accumulators are not used these wires must be adequate for the maximum current, which is three times as much as the average; the line could be worked without accumulators, but with less economy; if accumulators are used 200 hp would suffice for the power plant, but if they are not used it would require 300. An itemized estimate of expenses is given.

Canal Boat Hauling. Lond. *Elec.*, Jan. 17.—A short summary of the experiments which are being carried out at present on the Burgundy canal; two methods are being tested, one is to attach to the stern of the barge an electrically propelled iron boat, and the other to haul the barge by a motor secured to a frame suspended from an overhead wire. The current was supplied at 300 to 350 volts from a turbine-driven dynamo; using the "bachot propulseur," and a barge 36 metres long, with a square stern, the draught being about 1.5 metres, the following results were obtained with 13 to 14 amperes: For a load of 100 tons the speed was 3 km per hour, and for 230 tons it was 2.3 to 2.4; with a better type of barge, and a load of 70 tons, a speed of 4 km was obtained; two barges of 200 tons were hauled 2 km per hour with 10 to 12 amperes.

Railways in England.—An illustrated description of the Dublin-Dalkey railway, which is soon to be inaugurated, is given in the Lond. *Elec.*, Jan. 17; the Thomson-Houston system is used. The Coventry line, which was recently completed, is described, with illustrations, in the Lond. *Elec. Rev.*, Jan. 17; it was constructed by the General Traction Company.

Electric Bicycle. Arnoux. *Bul. Soc. Int. des Elec.*, December.—A reprint in full of the description of the Pingault bicycle, which was abstracted in the *Digest*, Jan. 4.

Electricity for Railways. Elec. Ry. Gaz., Jan. 25, and *Elec. Eng.*, Jan. 29.—An abstract of the yearly report of the Massachusetts Railway Commissioners, in which the use of electric motive power is discussed at great length. Most of the statements are already well known. They consider it in many respects an unsolved problem, nothing else having been proved thus far, except that sufficient power can be obtained, the question of economy being still unsolved; they even consider that the advantages of trolley over horse traction on street railways is unsettled as to economy; electricity is not satisfactory for freight traffic nor for long-distance passenger traffic; if there is any advantage it is in suburban passenger traffic, short-distance interurban traffic, or isolated traffic on branch and spur lines. The steam railways can recover the traffic they have lost, the remedy proposed being the electric equipment of their lines for suburban and other local service; it is considered certain that these roads could not, after introducing electric power, any more than now, afford to reduce the fares, other conditions remaining the same; however cheap electric power may be, it will be no cheaper for the steam railway than for the street railway; they question whether the introduction of a more frequent service would alone be sufficient to turn the main current from its present course.

In the former journal some of the statements from the report are criticised editorially. Attention is called to the fact that the cost of equipping and operating an electric road with a given number of cars, cannot be brought down to the cost of a horse railway of the same length and number of cars, but the difference in earning capacity more than compensates for the difference in cost of construction and operation. Furthermore an electric railway of a given length does not require nearly so many cars as a horse railway although it may handle double the number of passengers per day.

Surface Contact System. Schnepf. *Elec. Ry. Gaz.*, Jan. 25.—A brief, illustrated description of the system, in which there is an chain lying in a trough covered by sectional rails and under ordinary circumstances is not in contact with it; when the car passes over the rail a magnet on the car draws the chain into contact with that particular section of the rail, and the chain being connected to the feeders, makes that section alive while the car is passing over it. The sections are eight feet long and the rail is made of a non-magnetic metal. The chain is partly of iron and partly of brass. The system possesses the merits of simplicity and economical construction, but its commercial value has not yet been demonstrated in actual practice.

Conduit System of Paris. Elec. Ry. Gaz., Jan. 25.—An illustrated description of the one mentioned in the *Digest*, Jan. 18.

Niagara Gorge Railway. Dunlap. *Elec. Ry. Gaz.*, Jan. 25.—A brief, illustrated description.

Gas Motor Cars. Sc. Amer., Feb. 1.—An illustrated description of those used in Dessau, Germany, which have been referred to several times in these columns.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Tests of an Alternating-Current Plant. Kennedy and Thompson. Lond. *Elec.*, *Elec. Eng.* and *Elec. Rev.*, Jan. 17.—They refer to the trials made of the Brush generating plant at the Dover station; the results are given in tables in the two former journals and in abstract in the latter. A 25-ampere 2000-volt generator had an efficiency of 76.8 per cent. at full load, and 80 per cent. at 17 per cent. overload; this includes the exciter; a 40-ampere 20,000-volt generator had 80.6 per cent. at full load, and 81.0 per cent. at 20 per cent. overload; two machines for 50 amperes at the same voltage had an efficiency of 81.1 per cent. at full load; the results are considered to be highly satisfactory; similar figures are given for the steam plant, the results being also considered quite satisfactory. No difficulty was found in running the exciters in parallel; when the generators were run in parallel they "ran in general satisfactorily"; in some of the generators a metallic shield was inserted to protect the field winding from the armature coils, which is considered to be a very important improvement; the results of the whole tests are considered very satisfactory.

Phases of Polyphase Currents. Lond. *Elec. Rev.*, Jan. 17.—It is believed that no satisfactory, practicable method for converting single-phase into polyphase currents has yet been devised; one of the difficulties is the impossibility of maintaining any given phase difference under varying conditions of load; in using the ordinary system involving a capacity and a self-induction, if the current or pressure or both vary beyond a small limit, the phase difference changes and the method is therefore of use only for starting motors; Korda splits up a single-phase current into two differing by 120 degrees and by their transformation obtains another current, which with the other two makes a three-phase system, but it is thought doubtful whether these phase differences can be maintained under varying conditions; the Bradley system is described with the statement that it appears that no practical results have yet been obtained with it. If instead of the first device mentioned an extra motor winding, a small accumulator and an exciting dynamo are substituted for the condenser and choking coil, then a common alternator can be run as a synchronous motor; by another method the single-phase current may be rectified and used for a continuous-current motor, but this rectifier costs as much as the motor; another method is to use an ordinary continuous-current motor with laminated field magnets, but this can be used only for small powers; it is thought that these three proposals are the best that have been made, but they are not quite satisfactory.

Better Utilization of Central Stations. Rasch. Lond. *Elec. Rev.*, Jan. 17.—A translation of the article abstracted in the *Digest*, Dec. 14, on "Operating Meters for Different Rates of Charge."

Edinburgh. West. Elec., Feb. 1.—A reprint of Prof. Kennedy's recommendations abstracted in the *Digest*, Jan. 4.

WIRES, WIRING AND CONDUITS.

House Wiring Insulation Curves. Lond. *Elec.*, Jan. 17.—A set of curves based on the most recently published rules of different companies in England; they differ from those published before in important details, which, however, are not pointed out.

ELECTRO-PHYSICS AND MAGNETISM.

The X-Rays of Prof. Roentgen. Zeit. f. Beleucht., Jan. 10.—A brief editorial abstract of the recent paper of Roentgen. This is the article which has been referred to frequently in the daily papers in connection with the subject of "Photographing Through Opaque Bodies" (*Digest*, last week). He describes a new kind of rays which, to distinguish them from other rays, he temporarily calls X-rays. He used a tube with a high vacuum in connection with a Ruhmkorff coil, producing distinct cathode rays; he covered it with a black cardboard, and in a dark room he noticed that a paper shade, which had been covered with barium-platinum-cyanide, fluoresced at each discharge, whether the painted side was toward the tube or not; these rays not only went through the cardboard, but also through the bodies in their path, though in different degrees; as cathode rays do not pass through the glass tube, he concluded that these were entirely different rays which pass through most bodies much better than through metals; they pass through 2.3 cm pine boards at 2 metres distance without apparently any loss, but a 1.5 cm aluminum plate casts a decided shadow, while lead at that thickness was almost entirely opaque to them; their opacity increases with the thickness and appears to be affected by the density of the material; the rays do not show a regular reflection and refraction, but the bodies act toward them like translucent mediums toward light rays; the rays are distinguished from cathode rays in that they are not deflected by a magnetic field; they can be deflected, however, when the cathode rays in the tubes are deflected; the starting point of the rays is that part of the tube where the cathode rays strike it and from where the new rays radiate in all directions; it is therefore certain that they are different from cathode rays although produced by them. They act on the phosphorescent calcium compounds, on uranium glass, common glass, rock salt, etc.; also on a dry photographic plate enabling one to record the rays photographically; it is not yet certain whether they act chemically on the film of the plate, or whether they produce in the glass or gelatine a fluorescence which

then acts chemically; such photographs are in the nature of shadows and are made by leaving the plate in its wooden casing. It is suggested that at first sight they might be supposed to be ultra-violet light, but as they are not refracted or regularly reflected it follows that they are different from light rays; the same is true of their absorption, which seems to depend on the density of the bodies; Roentgen does not consider them ultra-violet light, but on account of the similarity of their action, with light, as in the formation of shadows, fluorescence and chemical action, which latter may be only secondary, he suggests that these new rays may be caused by longitudinal vibrations.

The *Elek. Anz.*, Jan. 12, in covering partly the same ground, adds that it is possible to make these photographs in broad daylight by keeping the plate inside of the case; it is known that cathode rays are deflected in straight lines by a synchronous magnetic field of alternating polarity, and it suggests that it would be interesting to notice whether this phenomenon also takes place with the X-rays; also whether the impregnated paper on which the fluorescence is produced, is partially transparent to these rays or whether it absorbs them completely; a constant magnetic field does not deflect the rays.

A dispatch from Vienna states that Dr. Neusserr, of Vienna, showed by means of photographs taken by Roentgen's system, the presence and position of calcareous deposits in the bladder, liver and kidneys of a subject.

Attention may here be called to an abstract in the *Digest*, Aug. 31, on "A New Form of Ray," discovered by Dr. Wiedemann, which has some properties resembling those of the Roentgen rays; they are different from those of light, and similar to cathode rays, differing from them, however, in that they are not acted upon by a magnet; he found that they are emitted by electric sparks as also by discharges in rarified gases; he called them "discharge rays."

Luminous Glow in Rarified Gases. ELSTER and GEITEL. Lond. *Elec.*, Jan. 17; translated from the *Wied. Ann.*, No. 12.—They describe their experiments to determine the motions of the luminous glow in rarified gases produced by electric oscillations; they are similar in some respects to some of Tesla's experiments; they draw some conclusions concerning the nature of the movable discharge.

Electricity. HOPKINSON. Lond. *Elec. Eng.*, Jan 17.—Beginning ot a reprint in full of the inaugural address of Dr. John Hopkinson, president of the Institution of Electrical Engineers. He begins with a review of the development of the science of electricity during the present century, and points out that the knowledge of electricity and magnetism possessed at the end of the last century was not the parent of the great applications of later days, and that the knowledge of the last century has not grown in any great degree, but that our advances were the results of discoveries made in the beginning of the present century. He then discusses how the theory of electricity would have been arranged if the order of discovery of the facts of the science had been other than it has been; after calling attention to the intimate connection between theory and practice, he proceeds to show how the facts of electrostatics can be explained by the facts of current electricity, without hypothesis, or in other words, how the science of electricity may be based on the theory of current electricity taken as fundamental, instead of the reverse, as usual. He suggests that the word current be not considered as signifying anything flowing along a conductor, as it is the name for a direct magnitude and nothing more. He begins the discussion with the description of the voltaic cell, calling attention to the fact that a metallic connection between the plates is a condition precedent to the chemical reaction and to the heating of the wire; it is to be continued.

Electricity in 1895. GUILLAUME. *L'Ind. Elec.*, Jan. 10.—An interesting review of that portion of the science of physics which relates to electricity; much of the matter given has already been referred to in these columns.

Fusion of Metallic Wires. MAURAIN. *Bul. Soc. Int. des Elec.*, December, and *L'Ind. Elec.*, Jan. 10. A reprint of a note read before the Société Int. des Elec.—The production of drops on the surface of wires which are not completely fused has generally been considered to be due to localization of the current on the surface of the wire, as a result of its oscillating character; but he reproduced this phenomenon by using a continuous current; as the intensity of the current increases, the drops are more or less well formed; they appear to be the same if the resistance, having a large self-induction, is placed in the circuit. He believes the cause of the formation of the drops is due to a capillary phenomenon; it is difficult to find out whether the drops represent masses in equilibrium or whether their forms are unstable, having been stopped in their transformation by solidification. He gives a table showing the number of drops per unit length, with different wires.

Resistance of Conductors to Alternating Currents. MASCART. *Bul. Soc. Int. des Elec.*, December.—A reprint of the complete article which was abstracted in the *Digest*, Jan. 18, under the heading of "Skin Effect"; it was there incorrectly attributed to Maurain.

ELECTRO-CHEMISTRY AND BATTERIES.

Theory of the Lead Accumulator. LIEBENOW. *Zeit. f. Electrochem.*, Jan. 5.—He describes in detail a theory which he proposed some years ago; he assumes that when a compound in solution can split up into ions simultaneously in different ways it will do so. He explains it in detail and concludes that the process in the lead accumulator is as follows: Owing to the low solubility of the lead salts and the low degree of dissociation of water, the lead ions, as also those of the water, contribute almost nothing to the conductivity of the electrolyte; this conductivity will be determined chiefly by the sulphuric acid; when a charging current flows through the accumulator only the peroxide and the lead ions in the solution will be set free, as they represent the least work of the current. Owing to their small number, however, they would soon be exhausted in the immediate neighborhood of the electrodes, if the lead sulphate on the electrodes did not immediately go into solution after the deposition of these ions. When all the lead sulphate on one of the plates has thus been exhausted, a further current will electrolyze the water.

Electrolysis of Chlorides. LORENZ. Lond. *Elec. Eng.*, Jan. 17; abstracted from the German.—The chief difficulty in the electrolysis of zinc chloride is to get rid of the water; after fusion there will be an evolution of gas when the current is started, due to the presence of water; as the zinc which is first deposited is not pure, the molten chloride is poured into a second vessel as soon as the less positive metals have all been deposited and is then again electrolyzed, when pure zinc will be deposited. Fused lead chloride is easily electrolyzed in a similar way; silver chloride dissolves in zinc and lead chlorides, from which the silver is deposited first; copper chloride is slightly soluble in zinc chloride and can be electrolyzed with a cathode of molten zinc when all the copper is obtained as a zinc-copper alloy; when a mixture of fused metallic chlorides is electrolyzed, the metals are deposited one after the other and can be obtained pure by fractional electrolysis; as a result of his experiments he devised a practical method for obtaining zinc and lead from their ores, which is probably the one mentioned in the *Digest*, Nov. 30.

Electrolytic Amalgams. ANDREOLI. *L'Elec.*, Jan. 18.—In the continuation of his article (*Digest*, last week) he points out the great value of amalgams in metallurgy, if they can be produced easily, rapidly and cheaply; he states that electricity has solved this problem and that sodium amalgam can now be produced by a continuous process. Sodium amalgam becomes solid when it contains more than 1 per cent. of sodium (this does not agree with what follows); with 30 parts of mercury to 1 of sodium it forms a hard body which can be filed; with 40 parts of mercury it becomes soft, with 60 it forms a hard paste, with 80 it loses its consistency, with 86 it shows small crystals, with 100 it is viscous, and with 128 parts of mercury to one part of sodium it is liquid.

ELECTRO-PHYSICS AND MAGNETISM.

Prof. Roentgen's Photographic Work. Elec. Eng., Jan. 29; a reprint from the New York *Sun* (see *Digest* above and last week).—The process has already been used successfully by European surgeons for locating bullets and other foreign substances in the human body and in diagnosing diseases of the bones of the body. Another important application is in metallurgy; any internal defects or lack of homogeneity are quickly detected and recorded, with a sensitiveness and accuracy which is claimed to be marvelous. Lead is almost as transparent as aluminum and wood; for testing the uniformity of structure of metal work, such as gun barrels, for instance, it is claimed to be very useful; metallic objects exposed to these rays show in the photographic reproduction all inequalities, such as fractures or cavities; this quality is said to be due to the great sensitiveness of these rays, to variations in the thickness of the metal; furthermore the carbon is readily distinguished from iron, and it is thought that it may be possible to recognize the quality of steel and iron. The latest experiments seem to show that nothing is absolutely impenetrable to these rays and that it is only a question of degrees of transparency; a large metal plate which had been broken and welded together so that the line of fracture was imperceptible, was photographed by means of these rays which showed the joint very plainly. A living skull without the flesh was photographed. As these rays are incapable of being deflected by lenses or any substance, Roentgen believes that perhaps they move with the same velocity in all bodies, and in the medium with which the molecules of all bodies must be surrounded. The photographing of Mt. Blanc, mentioned in the *Digest* last week, is described, but seems to be based on an entirely different process.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Potentiometer. FISHER. Lond. *Elec.*, Jan. 17; third article of the series; *Digest*, Dec. 28.—He discusses the different adjuncts necessary; regarding the source of the steady current, he states that the ordinary primary batteries are too troublesome to be considered at all; he gives curves for the Obach and the E. C. C. dry cells, which he says are admittedly the best, but the fall in voltage is too great; when the instrument is not to be transported a secondary battery is an ideal source, provided there are suitable means for charging it; the fall of voltage on the flat portion of the discharge curve is almost negligible; in the size of cell usually adopted it is less than 0.0004 volt in 15 minutes; a set of curves is given. They should be of fairly large capacity, say 15 or 20 ampere-hours, so that they may be left on closed circuit continuously, and the instrument is then always ready for use; after a full charge the initial voltage should be gotten rid of by a partial discharge through a low resistance; the instrument should never be connected to one of a number of cells in series, but always to an isolated cell.

Regarding the galvanometer the principal features required are dead beatness, sensibility, freedom from vibration and freedom from the interference of stray magnetic fields; for these reasons the d'Arsonval instrument is the one best adapted; he gives an illustrated description of the one devised in Mr. Crompton's laboratory; it has a sensibility of 2 mm at 2000 mm for a potential of 0.000001 volt, and a period of 2 seconds; the larger instrument has a sensibility 6 or 8 times as great but a slower period. He prefers working with the image of an incandescent lamp filament thrown from the mirror on the back of a piece of ground glass placed close to the operator, and on a level with his eye; this is a great saving of the eyes, and enables readings to be made in the brightest daylight. He states that if the silver wire on the usual forms of the d'Arsonval instrument be removed and a fine phosphor-bronze strip put in its place, as used by Prof. Ayrton, the sensibility is increased 20 fold.

Increasing the Sensitiveness of a Galvanometer. Classen. *L'Ind Elec.*, Jan. 10.—A long abstract in French of the paper abstracted from the German in the *Digest*, Nov. 16.

Effect of Temperature and Electrification on the Insulation of Gutta-percha. Zielinski. *Elek. Zeit.*, Jan. 9.—The first part of a long paper contributed by the German Government Telegraph Department. He describes a long and carefully made series of experiments, covering a period of over a year; the present portion relates to the measurement of the temperature coefficient of gutta-percha, and to its heat conductivity, the latter being for the purpose of showing how much time must be given the material to acquire the temperature.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Researches with the Discharge of the Electric Ray. d'Arsonval. *Bul. Soc. Int. des Elec.*, December.—A description of his experiments with the electric discharges of this fish; it appears to be substantially the same as the article abstracted in the *Digest*, Aug. 24. The E. M. F. (strictly speaking the difference of potential at the terminals) varied between 8 and 17 volts, and the current between 1 and 7 amperes; this was through the circuit of his instrument, but on open circuit the E. M. F. of the organ can exceed 300 volts; to measure this he used a Kelvin multicellular electrometer, which was connected to the organ at the moment of maximum discharge, one of the two independent organs being used to operate a polarized electromagnet which closed the circuit of the second organ with the electrometer at the moment of its maximum intensity. He explains the phenomenon of the generation of the charge in the organ of the fish as follows: The organ is composed of about 500 hexagonal prisms, each divided into 2000 cells by membranes, each cell containing two distinct substances, one of which is granulated and the other glassy; these do not mix, but have a surface of separation, the extent of which can be made to vary by means of the excitation of the electric nerve; at the moment of excitation the protoplasm tends to take the globular form, the surface of separation increases and is accompanied by an electric variation like in the Lippmann capillary electrometer; at the moment of contraction the protoplasm always becomes negative with respect to the surrounding medium; at the moment of discharge each cell is the seat of an electric oscillation, the granular substance being negative and the glassy positive; the cells are connected in series, the difference of potential at the extremities of a prism being therefore 2000 times that of a single cell; the prisms are connected in quantity.

Electricity in Medicine. Hedley. Lond. *Elec. Eng.*, Jan. 17; abstracted from *The Lancet.*—A current from a dynamo cannot be considered absolutely uniform on account of the pulsatory character due to the commutator; but this is not the case with currents from central stations, as in that case there are always a number of dynamos connected together. Comparing a lighting current reduced by a resistance in series with it, with one produced by a Leclanche battery of just the right voltage he states that greater pain follows from the former, which is decreased by pressing the electrode, the explanation being that an imperfect contact may then have a high voltage across it, and this may cause considerable local heating. There is a different physiological effect produced by the so-called faradic current than that from sinusoidal currents; the latter is better tolerated than the former, but the former can never be entirely supplanted by the latter; where effects on general nutrition, other than muscular contraction, are sought, the smoother curved currents have decidedly the advantage; d'Arsonval has shown that with sinusoidal currents, which are scarcely felt, the nutritive exchanges undergo an augmentation of from 40 to 50 per cent., which is thought to be due to the decompositions and recompositions which must accompany a passage of the current through the tissues; the alternating currents of commerce, which approach smooth curves, present a means of increasing the nutritive exchanges; they are employed daily in practice, and seem to act as a general tonic. He believes "the time ought to be approaching when electricity will be prescribed and administered not only in measured units of intensity, density and time, but with definite ideas of the shape of the E. M. F. curve, and of the therapeutic indications that a given curve may be expected to fulfill."

Glucinum. Lond. *Elec. Rev.*, Jan. 17.—The price of this metal is now nearly $18 per pound; it is a white metal of a specific gravity of 2.1, that of aluminum being 2.6; it is malleable, may be forged, rolled into sheets, and will take a high polish, does not tarnish in the air, and resists the action of most oxidizing agents; its electrical conductivity is as high as that of silver, and therefore higher than copper; its price is only $\frac{1}{10}$ that of platinum, weight for weight, and 160th volume for volume; it is thought that if the supply is sufficient and the methods of production are improved, it will find useful application in the electrical industries; it was formerly known by the name of beryllium.

Electro-Pneumatic Brake. Chapsal system. Lond. *Elec. Rev.*, Jan. 17.—A translation of the article mentioned in the *Digest*, Jan. 11.

Biographical.—Lond. *Elec.*, Jan. 17. A full-page steel portrait of Dr. John Hopkinson.

The "K R" Law as Applied to Quadruplex Circuits. Finn. *Elec. Eng.*, Jan. 29.—For long lines the quadruplex is far from perfect, due to the want of a receiving apparatus with a sufficiently low time-constant; the distance to which it is now possible to operate quadruplex successfully is limited by the capacity K and the resistance R of the line, and the number of signals that can be transmitted per second depends on the product, $K R$; the applicability of this law to the quadruplex had not been generally known or appreciated. He suggests that for each of the improved systems in use the value of this $K R$ should be found to serve as a standard for determining their working capacities and the distances. He made two such measurements, and concludes that it may be considered fully established that when the $K R$ equals 10,500 it is an excellent working quadruplex circuit, and when it is equal to 35,938 it is an impracticable working quadruplex circuit.

Machine Telegraphy. Delaney. *Elec. Age*, Jan. 25.—A reprint with illustrations of the article abstracted in the *Digest*, Jan. 25.

MISCELLANEOUS.

Commercial Exploitation of Electricity. B. E. Greene. *Eng. Mag.*, February.—He assumes that the electrical industry in the United States is not in a commercially healthy condition and that it has never returned to the investor any reasonable profit; he points out the reasons for the past and present unsatisfactory conditions. The article includes a list of the electrical and manufacturing companies of New York State for the past 20 years.

New Book.

Poor's Directory of Railway Officials and Manual of American Street Railways. Tenth annual issue. New York: H. V. & H. W. Poor. Royal octavo; cloth. Price, $3.00.

Poor's Directory for 1895, carefully revised up to Oct. 25 of last year, made its appearance at an unusually early date. The Directory comprises 700 pages, and includes all of its old standard features and quite a number of new ones. Among the additions are a comprehensive table giving the dividends paid by railway traction and industrial corporations during eight and one half years and up to the close of the present fiscal year. There are also presented extended tables of financial and mileage statistics. Street railways, electric, cable and horse, are given special statistical discussion. In addition to the officials of each company there are statistics of mileage, construction, equipment, capitalization, and much other data of great value. The whole work is systematically tabulated and well indexed, so that the desired information can be obtained with the least labor spent in searching.

An Arc Lamp Hanger.

The advantage of a hanger by means of which an arc lamp may automatically be cut in and out of circuit when necessary to trim or readjust the lamp is evident, as danger to life is thereby entirely obviated. In the

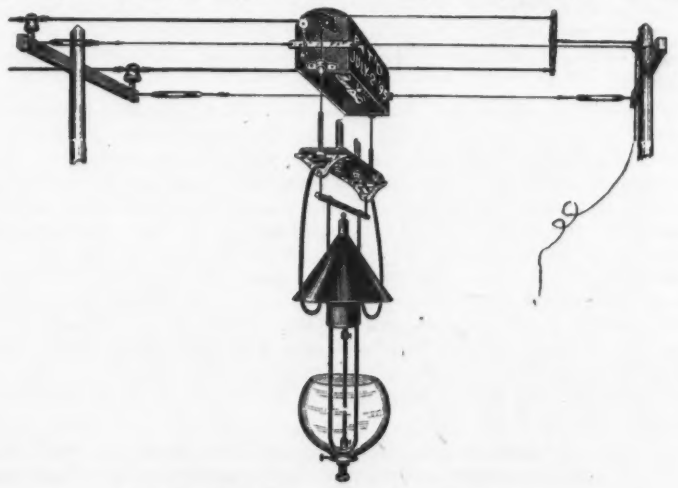


Fig. 1.—Hanger and Lamp in Position.

hanger which we illustrate, made by the Safety Arc Lamp Hanger and Improvement Company, 411 Francis Street, St. Joseph, Mo., this desirable end is attained in a simple and practical manner, as will be seen by referring to the illustrations. Fig. 1 shows the manner in which the hanger is

suspended, from which it will be seen that the line wires are a stationary fixture, thus enabling the line to be always kept taut, and reducing the liability to breaking the circuit. The two lamp suspension cables, which are separated by a spreader, pass over a pulley, after entering the hanger case, and take hold of the lamp hanger proper. Contact is made by means of two plugs which enter clips, and when in this position throw out a circuiting switch, thus establishing a circuit from one plug and clip through the lamp and out at the other plug and clip.

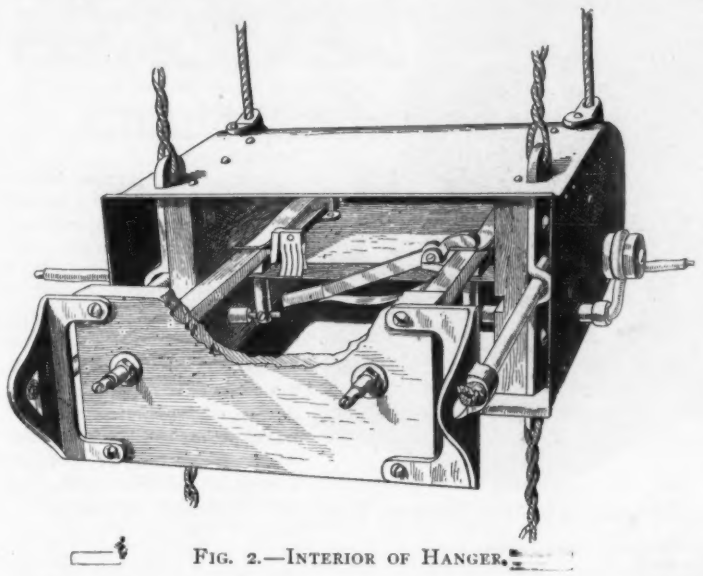


FIG. 2.—INTERIOR OF HANGER.

When the lamp is lowered, as soon as the plugs drop out of the clips, by means of a very simple mechanism, the circuiting switch is thrown; by this system the line circuit always remains closed. Should the cable break, by which the lamp is raised or lowered, the lamp is prevented from falling by the spreader coming in contact with the sides of the hanger case.

From this description it will be seen that the lamp circuit is broken automatically when the lamp is lowered for trimming or adjustment, at the same time the line circuit being continued through a circuiting switch; and that when the lamp is again raised into position it automatically establishes its own circuit, the circuiting switch then being thrown out. It is claimed that this form of hanger enables a large saving to be made in the cost of street construction, and much simplifies the hanging of lamps where trolley or other wires ordinarily interfere.

Tests of Rail Bonds.

Mr. Robert Dunning, master mechanic of the Buffalo (N. Y.) Railway Company, has recently made a number of tests on railway bonds, a synopsis of which we print herewith:

Copper Bonds.—Joint of 9-inch girder rail with one No. 00 bond, 6 inches long through rail base. Contacts clean, tight and new:

160 amperes,	.055	volt drop.	
1200 "	.28	" "	Bond warm.
1400 "	.35	" "	Bond very hot.

Same bond with one No. 0 copper wire newly fastened with channel pins:

200 amperes,	.04	volt drop.	
1200 "	.28	" "	Bonds warm.
1500 "	.30	" "	Bonds very hot.

Plastic Bonds.—Joint of 9-inch girder rail, with standard type of plastic rail bond between web of rail and angle plate, on one side only:

160 amperes,	0.01	volt drop.
1200 "	.09	" "
1400 "	.11	" "

Plastic Plug Bond.—Joint of 6¼-inch girder rail on chairs, with T-rail under joint; one pair of ⅝-inch holes through chair and rail-base into top of T-rail; holes amalgamated and filled with plastic alloy:

300 amperes,	.03¼	volt drop.	
1200 "	.13	" "	
1400 "	.16	" "	Cold throughout test.

Plastic Plug Bond.—Same as above, but with one pair of ⅝-inch holes on each side of rail, amalgamated and filled as above stated:

190 amperes,	0.01	volt drop.	
1200 "	.11	" "	
1500 "	.12	" "	Cold throughout test.

Alloy Bond.—Joint of 8¼-inch girder rail, with horizontal hole ⅞-inch in diameter in abutting rail-ends, with grooved steel dowel pin, amalgamated and filled with plastic alloy:

150 amperes,	0.00¾	volt drop.	
1200 "	.10	" "	
1400 "	.12	" "	Cold throughout test.

In these tests current was sent through the rails and joints, and its amount, as well as that of the drop, noted. A 9-inch rail, weighing 90 pounds to the yard, showed a drop of .0025 volt per foot with 250 amperes. A 6¼-inch rail, weighing 62½ pounds to the yard, showed a drop of .005 volt per foot with a current of 350 amperes. In these tests a milli-voltmeter was used which read to .04 volt, so that extreme accuracy was possible.

Arc Lamp for Low-Potential Circuits.

A recent addition to low-potential arc lamps is the Ajax lamp, manufactured by C. S. Van Nuis, of 136 Liberty Street, New York, of which we herewith illustrate a few designs. Fig. 1 shows an ornamental brass lamp with an opal globe and a rich, cast-brass corona. Fig. 2 illustrates a black japanned case, with a round globe and spark arrester, as arranged for out-door use; the resistance coils are mounted upon porcelain insulators on a detachable frame within the tube at the top of the lamp, making the lamp complete in itself and presenting a compact and neat appearance. Fig. 3 shows practically the same lamp as Fig. 2, with the spark arrester removed, and illustrates the type of globe-holder adopted for use with these lamps, which is only one of the many little ingenious devices that enter into the make-up of the Ajax lamp, contributing toward a serviceable and artistic whole.

Among the points of superiority claimed for the Ajax lamp are the absence of complicated parts and mechanism. The regulation is accomplished by a single magnet which attracts an armature through a long arc, and controls at the farther end of a rock-shaft a triple movement, which acts upon the rack or upper carbon rod. This triple movement is accomplished in an ingenious manner by a simply constructed movement frame and brake-wheel, which will admit of the lamp striking approximately a normal arc, and maintaining a uniform candle-power throughout the life of the carbons. Where one movement alone controls the regulation of a lamp, it may be said that maximum mechanical simplicity has been attained, but it is questionable if any movement, either electrical or mechanical, can be applied directly to the upper carbon of a lamp, so as to obtain an accurate adjustment of the arc under the varying conditions of a practical working electric circuit. So far as the simplifying of the controlling movement to a single unit is concerned, the designer of the Ajax lamp has reached that goal; but he has deemed it advisable to introduce the more sensitive triple-movement into the feed mechanism, in order to insure a more gradual and delicate adjustment of the arc than could be obtained by applying a simple magnet movement direct.

Fluctuations of electrical potential are fatal to a close regulation in arc lamps governed by too crude a movement between the governing magnet

FIG. 1.

FIG. 2.

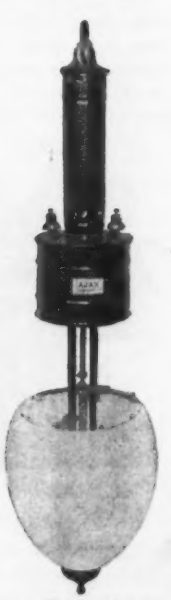


FIG. 3

and the arc, and it is claimed for the present lamp that a considerable variation in the governing magnet, due to a sudden rise or fall of potential of the current supplying the lamps, will effect the arc but slightly, because such sudden variation is largely compensated for by the threefold movement above described. It would appear, therefore, that with a closely regulated circuit, the Ajax lamp would feed by inappreciable increments, giving an absolutely steady light, and that with an ever-varying potential these fluctuations would be minimized at the arc.

Electricity in Mining.

We illustrate herewith several examples of electrical apparatus for mining purposes, made by the General Electric Company, which has given this application particular attention. Fig. 1 shows a 6½-inch by 8-inch horizontal pump, directly driven by a 10-hp, four-pole, slow-speed motor through two reduction gears; the entire combination is on the same base, being mounted on a truck for ready transportation from place to place in the mine. The motor is controlled by a rheostat set at the side, and, like

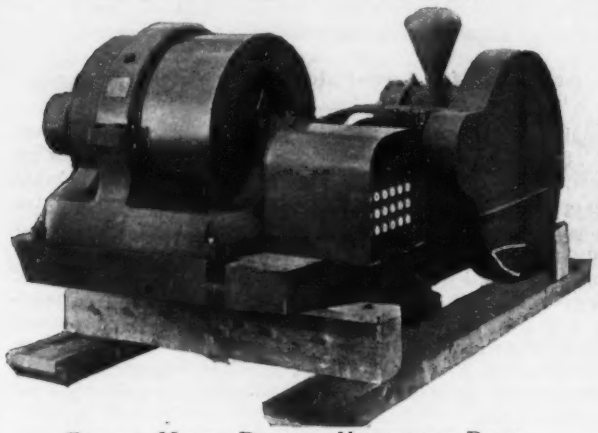


Fig. 1.—Motor Driving Horizontal Pump.

the motor, housed in with a sheet-iron cover. The illustration shows the truck mounted on a wooden base for shipment.

Fig. 2 shows a No. 4 Root blower, driven by a four-pole

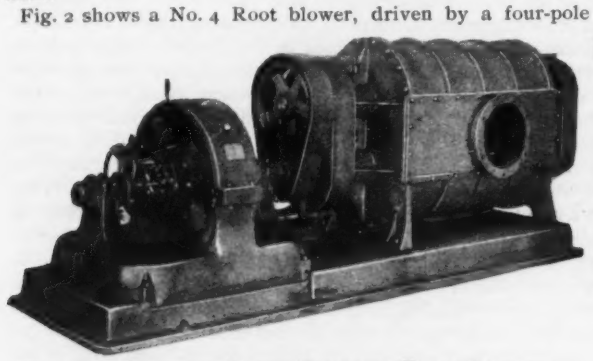


Fig. 2.—Electric Motor Driving Root Blower.

slow-speed motor of 15-hp capacity, and mounted on a common base frame. Fig. 4 is a 60-inch steel-plate exhaust fan operated by a 2½-hp four-pole motor. The fan makes 480 revolutions per minute, and has a capacity of 8300 cubic feet of air per minute at ¾-ounce pressure.

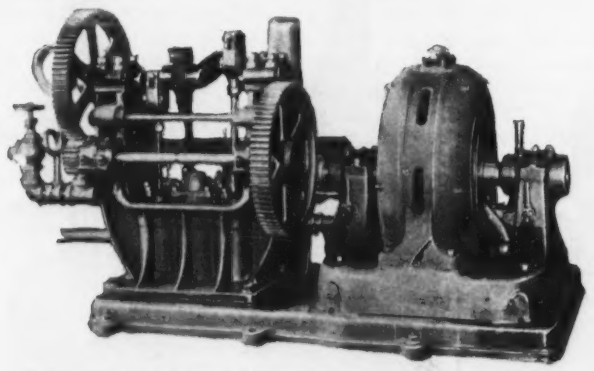
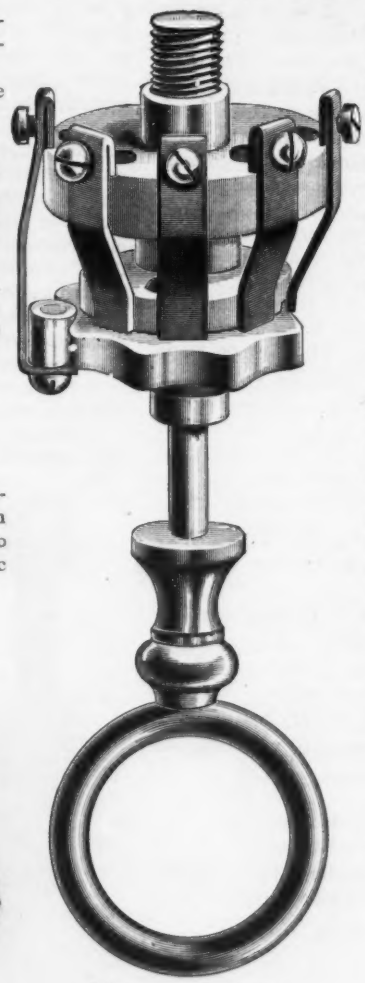


Fig. 3.—Multiphase Motor Driving Vertical Pump.

The slow-speed motors driving the above-mentioned apparatus are recent developments in the motor line, and are designed for use on direct-current circuits. For outputs greater than five horse-power, they present decided advantages over motors of bipolar type. They are compactly built and admit of direct combination with machinery without increasing the space occupied to any great extent. They operate at slower speed than other motors of similar capacity, and although reduction of speed must necessarily imply increase of weight, yet in this case it is claimed to be amply compensated for by economy of material effected by the adoption of the four-pole type. The frames and fields are of special soft cast steel, which, possessing high magnetic permeability, allows of the construction of a motor lighter than other motors of the same output at higher speed. The armatures are thoroughly ventilated, and the windings of copper wire, first formed and insulated, are embedded in slots in the armature core, and bound down securely on the projecting flange of the armature spider. The coils can be easily removed and replaced, and the insulation is the excellent result of years of experience. The machines are sparkless, and the load can be varied from nothing to full load without the necessity of shifting the brushes. Precautions are taken to prevent any tendency on the part of the bearings to get out of alignment, and proper contact of brushes with the commutator is insured by special construction of the brush holders.

Fig. 4.—Motor Driving 60-Inch Exhaust Fan.

Another combination, introducing the multiphase motor for use on alternating-current circuits, whether monocyclic or multiphase, is shown in Fig. 3, which illustrates a triplex vertical, single-acting pump, directly connected to a 220-volt, 60-cycle, 10-hp multiphase motor. This type of motor, developed by the same company, aside from its compactness, which allows of its erection in a restricted space, has the additional advantage of being absolutely without brushes, commutator or moving wires. It requires no attention, and may be stopped and started under full load or no load; in fact, it has all the advantages of the best type of direct-current motor, with better regulation and without any of the disadvantages which the presence of commutators, brushes and a wire-wound armature may develop. These motors are now in use on all the three-phase and monocyclic-power transmission circuits in this country, operating without attention or accident, and to the entire satisfaction of the user.



Multiple Switch.

The Cassidy Switch.

The fixture switch, illustrated herewith, made by the Cassidy & Sons Manufacturing Company, 133 West Twenty-third Street, New York, is adapted for combination or electric fixtures, and is so designed as to be strong, simple and durable, and not liable to be thrown out of order by use. The switch is made for any number of lights from two to eight, one or more of which can be thrown on or off by a single motion. It is claimed to be the only reversable fixture switch on the market, and being constructed on scientific principles and well made, it has passed successfully through severe tests and received strong endorsements from those competent to judge.

Gasoline Blow Torch.

Hot Blast Blow Torch.

The gasoline blow torch we illustrate, made by the White Manufacturing Company, 40 State Street, Chicago, is claimed to be constructed on a new and scientifically correct principle, whereby a solid blue flame of intense heat is produced. The weight is very small in the ordinary size, being only two pounds empty and three pounds when filled with oil. The "Combination" torch, as it is called, is a combined brazer, soldering-iron heater and blow torch, thus combining three different tools in one, and is warranted never to blow out.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Feb. 1, 1896.

ERIE TELEGRAPH & TELEPHONE is a shade stronger this week, the cause probably being the approach of the quarterly dividend period. The company's report for the quarter ended Dec. 31, 1895, shows net earnings by the sub-companies of $117,276.99, an increase of $18,943 14 over the corresponding quarter of 1894. Of this amount the Erie Telegraph & Telephone Company receives $72,325, as compared with $61,587.50 in 1894. The fixed charges, however, are $19,320.87 for the quarter, which is $13,671.90 more than for the last quarter of 1894, so that after deducting dividend charges the surplus is only $5004.13, as compared with $7938.53, a decrease of nearly $3000.

COLUMBUS STEEL RAILWAY.—Sales of this stock are reported around 45, while last week as high as 50 was bid for it. Under the laws of the State of Ohio any street railway operating eight miles of track may run its cars over one mile of track of any other established road and one mile for every additional eight miles it may operate. Under this provision the Columbus Central Railway has applied to the Common Council for permission to run its cars over one mile of the Columbus Street Railway track on High Street, the principal thoroughfare of the city. This permission, even if obtained, would affect the Columbus Street Railway but little, it is said, because through cars would have to be run, and when the mile had been traversed the cars would have to return to their own track on side streets.

NORTH SHORE TRACTION preferred and common continue to hold their own and are in fair demand. The yearly report shows an increase of $99,024 in net earnings.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	94	96
" " " Brooklyn	100	110	115
" " " Boston	100	145	150
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	32½	34¾
Electric Storage, pref	100	33	34
General Electric	100	30¼	30⅜
General Electric, pref	100	60	63
Westinghouse Consolidated, com	50	31	31½
" " pref	50	54	54½

BONDS.

Edison Electric Ill., New York	105	105½	105½
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	..	90¼

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	..	200
American District Telegraph	100	33	40
American Telegraph & Cable	100	..	93
Central & South American Telegraph	100	117	120
Commercial Cables	100	150	..
Erie Telephone	100	62	63
Gold & Stock Telegraph	100	105	..
New England Telephone	100	..	89
Postal Telegraph-Cable	100	82	83
Western Union Telegraph	100	84¼	84½

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	17	17¼
Binghamton RR. com	100	100	..
Brooklyn Traction	100	7½	9½
" " pref	100	47	50
Buffalo St. Ry	100	68½	71
Cleveland Electric Ry	100	59	60¾
Columbus St. Ry	100	44¼	47
Hestonville	100	48	..
Long Island Traction, all pd	100	20	20½
New Orleans Traction	100	16	18
" " pref	100	64	67
North Shore Traction	100	30	33
" " pref	100	78	82
Rochester St. Ry	..	27	35
Steinway, Ry	..	50	..
Union Ry. (Huckleberry)	100	112	115
Union Traction, rcts $5 pd	..	10¾	11⅛
West End, Boston	150	66	66½
" " pref	100	93	..
Worcester Traction	100	12	14
" " pref	100	82	84

BONDS.

Buffalo St. Ry. 1st con. 5s	100	103	106
*Binghamton Railway Co. 5s	100	90	100
Cleveland Elec. Ry. 1st mtge 5s	100	100	103
*Columbus St. Ry. 1st 5s	100	98	101
Rochester St. Ry. 1st 5s	100	98	101
*Union Ry. 1st mtge 6s	100	105	108
*Westchester Electric 1st mtge 5s	100	98	101

* With accrued interest.

BROOKLYN EDISON ILLUMINATING COMPANY reports for 1895 gross receipts of $621,149, of which $115,529 came in through the citizens' station during the last half of the year. The net surplus for the year, taxes, etc., deducted, is $267,349.23.

LONG ISLAND TRACTION.—The recent activity in Long Island Traction is attributed to the near approach of the delivery of the new securities. Each holder of 100 shares of Long Island Traction will receive a $1000 5 per cent. 50-year gold bond and 57½ shares of stock in the new Brooklyn Rapid Transit Company. The company has in the treasury $2,250,000 bonds and $1,000,000 in cash. Its earnings have been steadily increasing, and average at this season of the year about $12,000 a day.

BROOKLYN TRACTION securities, on the expected publication of the plan of the Nassau lease, strengthened somewhat, the preferred selling around 50 and the common at about 9. Lack of supporting orders, however, and the delay in the publication of the terms, broke both classes of stock, the former being "offered down" to 47½, and the common to around 7. Very little actual demand appears to exist for the stocks. The report of the company for the year ending Dec. 31 shows a decrease of $107,226, in gross earnings, and increase of $106,688 in operating expenses, and a consequent net decrease of $213,914.

BUFFALO RAILWAY.—The rumor that through the ownership of a small suburban street railway system the Buffalo Traction Company would again attempt to enter the city, caused Buffalo Railway stock to break sharply to around 70. The report of the State Railway Commissioners on the application of the Buffalo Traction Company furnishes some very interesting statistics regarding the largely increased traffic of the Buffalo Railway Company and the Crosstown Street Railway Company, which are operated under one management. In the past five years the street railway mileage has increased from 66¾ to 143 miles, and the number of passengers carried from 16,024,847 in 1890 to 44,964,607 in 1895. In 1890 there were but 93 cars operated, while in 1895 the number was 301. For the fiscal year ending June 30, 1895, something over 12,000,000 passengers were transported.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Feb. 3, 1896.

MR. A. L. DANIELS, representing the H. B. Camp Company, of Aultman, O., was a visitor in New York last week. Mr. Daniels reports a great and growing demand for the Camp Conduit, and is able to claim some of the largest telephone, telegraph and electric light companies as customers, who have found by experience that this type of conduit is entirely satisfactory under the most trying circumstances.

INTERIOR CONDUIT & INSULATION COMPANY.—At the annual meeting of the Board of Directors of this company, held at its offices in West Thirty-fourth Street, on Jan. 27, the following officers were elected for the ensuing year: President, E. H. Johnson; vice-president and general manager, A. C. Bakewell; secretary-treasurer, C. P. Geddes; John S. Wise was also added to the Board of Directors.

THE PATCHOGUE & PORT JEFFERSON TRACTION COMPANY has been incorporated with a capital stock of $400,000, $100 a share, and the following officers: Edwin Bailey, president; O. T. Fanning, vice-president. Several prominent men are connected with the company. Frederick C. Cocheu, secretary of the Nassau Company, is one of the directors. The company is formed for the purpose of building an electric road between Patchogue and Port Jefferson, a distance of 14 miles, and connecting the villages between.

THE NEW YORK & STATEN ISLAND TRACTION COMPANY, which was incorporated at Albany last week, is stated to have for its object the control of the trolley and other surface roads of Staten Island, as originally projected by Erastus Wiman. It is said to be an offshoot of the Philadelphia Traction syndicate which now controls the Metropolitan Traction Company of New York City, and is thought to be part of a plan to organize the trolley systems of Brooklyn, Long Island and Jersey City under the Philadelphia syndicate.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., Feb. 1, 1896.

PRATT & WHITNEY CO.—The new executive offices of this large manufacturing establishment at Hartford, Conn., are now occupied, and present a fair appearance in contrast with the old offices.

"A. O. C." BELT-DRESSING manufactured by the American Oil Company, Providence, R. I., has for a long while been one of its standard manufactures. Its merits, however, have always been so manifest wherever used that the

demand for it has increased to such an extent as to make it at present the most successful and popular of its specialties. In order to extend its use in lighting and power stations, a reduction of prices has recently been made. "Save your belts, power, machinery and bearings, and increase your product by the use of A. O. C. belt dressing," is one of its satisfactorily tested mottoes.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, Hartford, Conn., is about as busy as it can very well be, its various departments of manufacture being most severely taxed at present in taking care of its increasing business. Mr. J. J. Gates, general manager, and Mr. F. W. Davis, secretary, have both resigned from their positions, and the business of the company is now being carried on by Mr. C. G. Perkins, president, and Mr. Edward W. Hooker, secretary, the latter gentleman having recently interested himself in the company. Mr. Hooker brings to his new position a valuable experience in the manufacturing line, and is possessed of business and social qualities which should command continued success and make for him new friends in the electrical field. Mr. C. I. Hills, who has been in charge of the New York office, has been placed in charge of the selling department, and will work in connection with the managers of the various offices. Energetic and pushing management last year trebled the business of the company.

Washington Notes.

WASHINGTON, D. C., Jan. 31, 1896.

THE POTOMAC LIGHT & POWER COMPANY, of this city, has elected Cortlandt D. Cramp of the Cramp Shipbuilding Company, Philadelphia, a member of the Board of Directors.

JUSTICE PECKHAM, the new member of the United States Supreme Court, delivered his first opinion in that court this week. The opinion was in the case involving the right of the Government to condemn the real estate of the Gettysburg Electric Railway Company as a part of the National Park, located upon the Gettysburg battle-ground. Justice Peckham's decision reversed the decision of the court below, declared the law to be valid, and sustained the condemnation proceedings.

A BILL calling for an appropriation for the construction of an electrical cruiser, and means to provide electrical equipment for one or more cruisers already in service, has been introduced in the House by Mr. Arnold, of Pennsylvania, and referred to the Committee on Naval Affairs. The bill requires that the electrical cruiser be equipped with the Richard B. Painton system of electrical motors and propellers, and asks that the Secretary of the Navy be authorized to contract for the construction of such a cruiser, and also substitute a Richard B. Painton electrical propeller equipment in any vessel of the United States Navy at his discretion.

THE DISTRICT COMMISSIONERS recommended adverse action a day or two since upon the Senate bill to permit the Standard Telephone Company of this city and Baltimore to install and operate a telephone and telegraph plant and exchange in the District, which was submitted from the Senate Committee to the Commissioners for their examination and report. They call the attention of the committee to the report of the Commissioners, made on the instant, upon the Senate bill to permit the Home Telephone Company to operate in the District, and they say they have the same objections to the Standard Company as they had to the Home Company.

THE PROJECT of building a road from Washington to Annapolis, and thence to some point on the Chesapeake Bay, is proposed by the promoters of the Washington, Annapolis & Chesapeake Railway. The line is to be 26 miles long, and connection is to be made by steamer with the eastern shore and the Atlantic Coast. Gen. J. B. Seth, who was at the head of the Baltimore & Eastern Shore Road, is in the new enterprise. The capital stock is placed at $500,000. It is proposed to put an electric line along the same route with the steam road. The electric road would be used to carry freight and passengers between stations, as a feeder for the steam road.

THE SENATE COMMITTEE ON FOREIGN RELATIONS has granted a brief hearing to Representative McCormick, Admiral Irwin, and others in favor of the proposition of the Pacific Cable Company, of New York, for the construction of a telegraphic cable from the Pacific Coast to Hawaii. They represented that this company would undertake to construct the line provided for within three years, upon the condition that the United States would pay the company annually, for 20 years, a sum equal to $25 for each nautical mile of the line. The company is the one headed by Mr. Scrymser, which already controls cable lines off Mexico and South America.

THE OFFICIALS OF THE BEECHMONT CEMETERY COMPANY are making arrangements with the management of the Great Falls Electric Road to have a funeral car placed on the road, to facilitate the traveling to the new burial ground. The introduction of a funeral car will be a novelty to Washington, but its use in other cities has been fully demonstrated. Beechmont Cemetery is located about a mile and a half above Cabin John Bridge, contains 211 acres and fronts for about half a mile on the conduit road. When the Great Falls Electric Road is complete, the cars will pass within a few hundred feet of the entrance. The total distance of the cemetery from the city is about nine miles, too long to be visited in a carriage funeral, and hence the necessity of the funeral car. The car will be rather long, built especially for the purpose, with a raised dais in the floor to hold the casket, while seats will be arranged around the inside to accommodate at least 60 people. As soon as the railway is constructed as far as Cabin John Bridge a spur will be run westward to the cemetery entrance.

THE COMMISSIONERS gave a hearing to Attorney P. B. Adams for the Home Telephone Company this week. This company is seeking to have the Commissioners reconsider their bill for a franchise in the city, and report favorably upon it to Congress. Attorney Adams set forth some very fair arguments why the company should be chartered to do a competitive business with the Chesapeake & Potomac Company. He states that his company will conform to everything required of the existing company, and will make many concessions to the Government, and also to private subscribers, which they will carry out or forfeit a bond of $500,000. They will give 5 per cent. of their gross earnings to the District in payment for the privileges they want, and will furnish private telephones at $42 per year. They will leave spaces in their conduits, which they propose to bury only about 18 inches in the streets, for the use of the District free of charge, and leave spaces to rent to other companies, or they are willing to rent spaces in the conduits of the Chesapeake & Potomac Company. The Commissioners say they will reconsider the bill. In reporting unfavorably to Congress, they did so hoping to shut out other companies and bettering the situation by regulating the rates of the present company by legislation.

Pittsburg Notes.

PITTSBURG, Pa., Jan. 29, 1896.

THE ANNUAL MEETING of the stockholders of the Standard Underground Cable Company was held at the company's office, Room 61 Westinghouse Building, Pittsburg, Pa., at 2.30 o'clock p. m. Jan. 28. Nearly seven eights of the capital stock of $1,000,000 was represented either in person or by proxy. The following gentlemen (all of Pittsburg) were re-elected as directors for the ensuing year, namely: George Westinghouse, Jr., president of the Westinghouse Air Brake Company and the Westinghouse Electrical & Manufacturing Company; Robert Pitcairn, general agent and superintendent Pennsylvania Railway Company; Mark W. Watson, president the Exchange National Bank; J. W. Dalzell, vice-president the Exchange National Bank; Geo. B. Hill, president Pittsburg, Allegheny & Manchester Street Railway Company; John B. Jackson, president Fidelity Title & Trust Company; James H. Willock, president Second National Bank; John Moorhead, Jr., principal owner of Moorhead Bros. & Company, iron manufacturers; Joseph W. Marsh, the vice-president and general manager of the company. The report of the Board of Directors showed a total business of nearly $1,000,000, for the year 1895. During the year three quarterly divisions of 1½ per cent. each, and one of 2 per cent., were declared, and the remainder of the earnings were carried into surplus account, which now stands at $446,869, notwithstanding the fact that at the beginning of the year 1895 $100,000 was charged off on patent account, and $47,000 on account of bad debts, doubtful assets, etc., arising in the first 12 years of the company's existence. The company has been discounting its bills since March last, and closed the year with not one dollar of debt of any kind, except for December bills not subject to discount, or not due for discount on Dec. 31, 1895, and with cash and notes on hand amounting to double the unpaid December bills, to say nothing of accounts receivable considerably exceeding $100,000. Early in the year 1895 a large two-story and basement building (Factory C) was completed and occupied, adjacent to the company's other factories at the corner of Sixteenth Street and Allegheny Valley Railway, in the heart of the manufacturing district of Pittsburg, and Factory B was modeled into a three-story and basement building, 55 x 117 feet, of first-class, slow-burning construction. The original Factory A is a large four-story and basement building, and all three factories were equipped during the year with automatic sprinklers, thus greatly reducing insurance premiums, and making a serious fire practically impossible, and so obviating any danger of inability to fill orders on account of fire—an extremely important consideration—where, as in the case of this company, the orders have kept factory running night and day throughout most of the year. A large quantity of additional machinery was bought or built, and erected in the company's factories during the year, the most important part of which is a moderate-sized, but complete modern plant for the manufacture of rubber-covered wires and cables, so that this enterprising company is now prepared to furnish wires and cables of any kind a customer may desire, whether insulated with fibre, paper or rubber. All these improvements, costing between fifty and sixty thousand dollars, were paid for out of the current funds, without contracting any debt whatever on account thereof. The company carried over into January a large amount of unfilled orders, and the orders booked so far in January have been spread over a wide extent of territory, while the prospects for a large business in 1896 are considered very good. This company was the pioneer in the underground cable business, having been organized in 1882, and was for a number of years the only distinctively underground cable company in the United States. For a number of years past it has also been doing a large business in insulated wire of various kinds for overhead use. During the long period of its existence, its products have been installed and successfully operated in every State in the Union, and in many foreign countries, notably, Venezuela, Brazil and the Argentine Republic in South America, and in England, India, Australia, China and Japan. The newly elected Board of Directors will meet on Saturday of this week for the purpose of organizing its official staff, and it is expected that the officers will be the same as heretofore, namely: Geo. Westinghouse, Jr., president; Joseph W. Marsh, vice-president and general manager; F. A. Rinehart, secretary and treasurer; P. H. W Smith, assistant manager; C. M. Hagen, auditor; W. A. Conner, general superintendent manufacturing department, and Henry W Fisher, electrician and chemist. The company's branch offices are ably manned by Geo. L. Wiley, manager of Eastern sales department, Times Building, New York; E. W. Dugdale, 336 North Broad Street, Philadelphia, Pa., and J. R. Wiley, manager Western sales department, The Rookery, Chicago, Ill., at each of which places (as well as in Pittsburg) experienced construction corps are constantly maintained for the installation of the company's products.

Western Notes.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, Ill., Jan. 30, 1896.

THE GATES ELECTRIC MANUFACTURING COMPANY, manufacturers of the Gates multipolar dynamos and motors, has made an assignment.

THE ELECTRIC APPLIANCE COMPANY is distributing an attractive 1896 calendar, whose usefulness to central stations is enhanced by having printed upon it a carefully prepared moonlight schedule for the entire year.

MILWAUKEE, WIS.—William Nelson Cromwell has purchased all the street railway and electric lighting properties of this place for $5,000,000. The new company is to be called the Milwaukee Electric Railway & Lighting Company.

THE STANDARD ELECTRIC COMPANY, whose assignment was recorded on Jan. 16, has issued the following statement under date of Feb. 1st: Machinery and tools, $32,684.64; merchandise and manufactured machinery, $94,490.27; bills receivable, $5449.21; accounts receivable, $73,393.45; office furniture, $75; real estate, $60,400; stocks and bonds, $5,750; total, $272,242.57. Liabilities, $100,142.97. Excess of assets, $172,099.60. The general depression of business for some time past, together with the extreme difficulty experienced in making collections, has so affected the company's affairs that—notwithstanding their very large excess of assets—the directors feel it their duty to make an assignment at this time for the better protection of the creditors. Rumors having been circulated in some quarters detrimental to the officers of the company, and tending to discredit their motives in making the assignment, the foregoing statement is sent out over the signature of the treasurer. On the face of this statement there cannot be the slightest doubt of the ability of the company under any ordinary circumstances to pay out dollar for dollar of its indebtedness.

COLORADO NOTES.

DENVER, COL., Jan. 28, 1896.

COLORADO ELECTRIC LIGHT PLANTS.—A gentleman who is interested in several electric lighting stations in Colorado recently made the remark that one of the most hopeful signs of the times, so far as this State was concerned, was to be found in the improvement in the business of the electric plants. The electric light plants, he said, constituted the most reliable barometer by which to judge of the conditions of business in general. The reports which had come to him from stations, both large and small, throughout the State were, he said, of the most encouraging character.

IN COLORADO it is the universal prediction that the State is entering upon a period of unexampled prosperity, and every sphere of activity is expected to be largely benefited by the splendid achievements in the mining districts. Electrical interests form no exception. They suffered from the depression which followed the panic of 1893, but it is certainly confidentially believed that the end of the trouble has been reached, at least so far as Colorado is concerned, and the companies are hopeful in looking for a largely increased business; in fact, they report that the improvement has already commenced in earnest. The companies expect to share directly in the prosperity which has come to the gold miners. There will be a demand for a great deal of apparatus to be used in the mines for illumination and power. Several transmission of power schemes have already originated as a direct result of the activity in the Cripple Creek District. One scheme contemplates the erection of a large power plant at some point in the coal fields 30 miles distant from Cripple Creek, and the transmission of the current to the latter place. Another plan is that of utilizing a water-power not over 20 miles from the mines at Victor and Cripple Creek. The demand for electrical machinery is likely to proceed, however, from mining districts generally. As one mining engineer put it, "The miners see better times ahead now and are not afraid to branch out a little and make improvements.

THE COLORADO TELEPHONE COMPANY has been increasing in business rapidly within the last year, and has been greatly benefited by the development of the gold mines at Cripple Creek. The company has in fact found it out of the question to provide all the facilities which have been demanded. The demand for the construction of new lines and for better facilities has been such that the company will soon probably find itself in a position where it must raise considerable funds either by an issue of bonds or of new stock. During the last year there has been a largely increased revenue from the toll service, and the annual report will show an increase during the year of 300 new telephones on use. The growth of the Cripple Creek business has been enormous. The company has now six metallic circuits between Cripple Creek and Colorado Springs. The demand for communication between Cripple Creek and Denver necessitated a new metallic circuit between the latter city and Colorado Springs. During the last year a metallic circuit has been constructed between Leadville and Aspen, so that the latter city is connected with the long-distance system. Metallic circuits have also been completed connecting Pueblo with Trinidad, Col., and Raton, N. M., and Greeley by way of Fort Lupton, Plattsville and Brighton directly with Denver. An automatic exchange was established at La Junta, and La Junta and Rocky Ford have been connected. During the year 33 public pay stations have been established in Denver.

THE STATE CAPITOL is to have an electric light plant, the building having already cost the taxpayers about $2,000,000. The contract has just been awarded to the Mountain Electric Company, of Denver, and no expense will be spared in making it one of the best isolated plants in the State. The electrical apparatus will consist of two Weston Electric 50-kw, six-pole dynamos. The machines will be directly coupled to Armington & Sims engines, and will make 275 revolutions per minute. The dynamo room, which is located in the basement of the Capitol, will be fitted up with unusual regard for appearances. It will be wainscoted with Tennessee marble, and the switchboard will be constructed of the same material. Weston electrical instruments will be provided. From the switchboards 60 circuits will lead throughout the building and the grounds. For the illumination of the latter, Manhattan arc lamps will be used, supported on a special form of ornamental pole. The wires will all be carried underground in iron-armored conduits furnished by the Interior Conduit & Insulation Company, of New York, which the Mountain Electric Company represents in Denver. The work of wiring for the illumination of the grounds is also to be executed by the latter company. This company has already done a great deal of work in the capitol, and the contracts which have heretofore been awarded to it for electrical work in the building have aggregated $45,000. It has wired the entire structure, using for this purpose 200,000 feet of red core Habirshaw wire, which is concealed in metal-covered interior conduits made by the Interior Conduit & Insulation Company, of New York. It is probable that a third unit will be added to the generating plant in the near future, and space will be provided for it in the arrangement of the plant.

General News.

NEW INCORPORATIONS.

THE EAST MOLINE TOOL COMPANY, East Moline, Ill., capital stock, $75,000, has been formed by Adolph W. Shirring, Charles H. Pope and Edward B. Kreis, for the purpose of manufacturing and dealing in machinery, and building and operating electric light plants.

THE ORR ELECTRIC POWER COMPANY, Dillon, Mont., capital stock, $20,000, has been formed by Mathew Orr, William C. Orr, and Philip H. Poindexter, Dillon, Mont., for the purpose of furnishing electric light, heat and power, and doing a general electrical business.

THE NEW ENGLAND ELECTRIC SUPPLY COMPANY, Boston, Mass., has been incorporated by Henry Cole, Dedham, Mass.; Bracy Curtis, Medfield, Mass., and John S. Keenan and Henry N. West, Boston, Mass., for the purpose of dealing in electrical supplies. Capital stock, $10,000.

THE LITTLETON WATER & LIGHT COMPANY, Littleton, N. H., which is a reorganization of the Littleton Water & Electric Light Company, has been incorporated with a capital stock of $80,000. Those interested are Hunter Wykes, Victor Cumberson, C. R. Coolburn, P. R. Coold and A. E. Strain.

THE LATROBE, DERRY & YOUNGSTOWN ELECTRIC STREET RAILWAY COMPANY, Latrobe, Pa., capital stock, $200,000, has been formed by Hugh Keogh, Latrobe; Curtis H. Gregg, Greensburg, and Alexander Eicher, Greensburg, for the purpose of building an electric street railway.

THE POTOMAC LIGHT & POWER COMPANY, Alexandria, Va., has been formed by O. T. Crosby, L. E. Sinclair, H. T. Perdee, D. M. Anderson, Washington, D. C., and D. S. Mackall, Fairfax, Va., for the purpose of furnishing light, heat and power by electricity or otherwise. Capital stock, $500,000.

THE NEW YORK & STATEN ISLAND TRACTION COMPANY, New Brighton, S. I., N. Y., has been organized by Charles I. Horton, Arthur D. Chandler, Daniel H. Shea and Francis P. Lowrey, New York City, for the purpose of supplying power and building railways. Capital stock, $2,250,000.

THE TEXAS GIN & COMPRESS COMPANY, Cameron, Tex., has been formed for the purpose of constructing electric plants and water-works, and entering into other enterprises. The promoters are J. C. Goldthwaite, Galveston, Tex.; Willis Goldthwaite, B. I Arnold, R. S. Porter, and S. B. Ford, Cameron, Tex. Capital stock, $75,000.

THE PORT JEFFERSON ELECTRIC LIGHT COMPANY, Port Jefferson, N. Y., has been incorporated for the purpose of manufacturing and using electricity for producing electric light, heat and power. Those interested are J. V. N. Bergen, E. M. Davis, Charles P. Randall, C. F. Purick and W. T. Wheeler, Port Jefferson, N. Y. Capital stock, $7500.

THE MAYFLOWER GOLD MINING COMPANY, San Francisco, Cal., has been formed with a capital stock of $3,000,000, for the purpose of developing and operating mines and erecting electric and other plants for lighting mills and mines. Those interested are A. Hayward, San Mateo; C. D. Lane, T. M. Lane, Angels Camp; E. A. Davis, Nevada City, and W. E. Shepman, San Francisco, Cal.

THE HEYER STORAGE BATTERY COMPANY, Chicago, Ill., has been incorporated by Fritz Heyer, E. W. Adkinson and David M. Ball, for the purpose of manufacturing electro-surgical specialties, storage, cautery and illuminating batteries, electro-illuminating and cautery appliances, galvanic and other batteries and apparatus, and specialties in the general surgical and dental line. Capital stock, $50,000.

THE PATTON ELECTRIC TRACTION COMPANY, Chicago, Ill., has been incorporated in West Virginia, by J. Erb, William H. Patton, Daniel J. Haynes, Robert H. Sheppard and James P. Massie, of Chicago, for the purpose of purchasing, owning and selling letters patent of William H. Patton, for improvements, devices, etc., known as the Patton motor. Capital stock, minimum, $1,000,000; maximum, $2,000,000.

TELEGRAPH AND TELEPHONE.

GLASGOW, KY.—Glasgow is to have a telephone exchange.

WINCHESTER, KY.—Winchester will soon have a first-class telephone system.

FAIRVIEW, KY.—Fairview is to have telephone connection with Hopkinsville or Pembroke.

MIDDLESBOROUGH, KY.—Middlesborough is to have a long-distance telephone line to Knoxville, Tenn.

DOVER, N. J.—An effort is being made to have the Dover telephone system extended through Milford to Georgetown.

ALBUQUERQUE, N. M.—The Automatic Mutual Telephone Company has been granted permission to erect poles and strong wires.

MENOMINEE, MICH.—The City Council has passed an ordinance granting a franchise to local capitalists to erect a new telephone system.

INDEPENDENT, MICH.—A franchise has been granted to the Crowley Telephone Company, and work erecting poles will be commenced at once.

ALPHA, ILL.—Alpha is to have another telephone line. The new line is to connect Kewanee, Galva, Cambridge, Orion, Opheim, Andover, Lynn and Alpha.

CATTARAUGUS, N. Y.—The village trustees have granted permission to the New York & Pennsylvania Telephone Company to erect and maintain lines and wires within the village limits.

CLINTON, IA.—The Iowa Union Telephone Company has made arrangements to build a new line from Clinton to Dixon, Ill., this Spring and will probably replace all the instruments now in use with later models.

NORTH PLATTE, NEB.—A movement is on foot to organize a telephone company. It is proposed to organize a mutual company and place the

shares of stock at the actual cost of putting in each instrument, issuing a share for each instrument taken.

FALL RIVER, MASS.—It is rumored that the American Printing Telephone Company will shortly ask for a franchise. It is further rumored that the company will agree to furnish private lines for three quarters the sum the public ones cost under the present system.

CLARION, PA.—John S. Shirley, Jesse Kiehl, L. M. Shannon, J. W. Knapp and others have applied for a charter for an intended corporation to be called the Clarion Telephone Company. It is proposed to purchase, maintain, lease and operate telephone lines and exchanges within the counties of Clarion, Venango, Forest, Jefferson and Armstrong.

Electric Light and Power.

WAUSEON, O.—A new system of electric lighting will be put in.

HARVARD, ILL.—The electric light plant has been destroyed by fire.

ANITA, IOWA.—The subject of an electric lighting plant is being discussed.

ELWOOD CITY, PA.—The Town Council has passed an electric lighting ordinance.

TAMPA, FLA.—The Lighting Committee has recommended that an addition of 10 arc lights be put in.

PORTLAND, MICH.—The Village Council is contemplating the purchase of the electric light plant.

GOSHEN, IND.—The Council is looking forward to the municipal ownership of the electric light plant.

GREENWICH, O.—The citizens voted on Jan. 20 to issue $18,000 in bonds for the extension of the electric light plant.

CROWN POINT, IND.—The Crown Point Manufacturing Company will enlarge its plant and put in electric lights.

ZENIA, O.—The City Council has awarded a contract for city lighting to John R. Martin, abandoning the municipal plant.

STERLING, ILL.—An ordinance has been passed authorizing the issuance of $1000 bonds for the extension of the electric light plant.

NORFOLK, VA.—Electricity will soon be substituted for the lights now in use at the ferry docks in Norfolk, Portsmouth and Berkley.

BERLIN, CONN.—The Berlin Iron Bridge Company, it is reported, will soon furnish the town of Berlin with street lights free of charge.

DAVENPORT, IA.—The City Council has let a 25-year contract for arc lights at $70 per year for all night-service, and $56 for the moonlight schedule.

JUNCTION CITY, ORE.—The Junction City Council has granted Robert Clow and associates a 30-year franchise to erect and maintain an electric light plant.

PORT JEFFERSON, L. I., N. Y.—Port Jefferson is determined to have electric lights. A company has been organized with a capital of $7000. W. T. Wheeler is prime mover.

NEW CASTLE, COL.—The City Council has declared in favor of electric lighting, but is undecided whether to obtain it from a private company or to put in a municipal plant.

MARTHA'S VINEYARD, MASS.—An electric light company has been organized, of which John Duggan is president, John R. Graham, secretary, and Josiah Quincy, of Boston, a director.

ST. CLOUD, MINN.—The plants of the Water, Light & Power Company have passed into the hands of C. U. Benson as receiver. The company defaulted in the payment of $9000 interest upon $447,000 in bonds and $25,000 in floating indebtedness.

WYOMING, PA.—Bids will be received by the Council of the Borough of Wyoming for furnishing arc lights of 2000 cp, to burn from dusk to daylight. The borough agrees to commence with 35 arc lights, with the privilege of increasing the number at any time. A contract to be made for eight years.

NORTH PLATTE, NEB.—A proposition will soon be placed before the City Council asking it to take some action toward securing electric lights for the city. The American Water Works, which owns a water-power, is willing to put in both an arc and incandescent plant if the Council will order 15 arc lights for town use.

LOWELL, MICH.—An electric light and power plant, consisting of 60 arc lights, 1000 incandescent lights and 100 hp for motor service, is to be built for the City of Lowell. Bids will be received up to 8 o'clock, p. m., Feb. 18, 1896, by Hon. C. Bergin, president of the board. Copies of the specifications can be secured by applying to Humphrey & Carr, engineers, 22 Bennett Building, Detroit, Mich.

CHICAGO, ILL.—Sealed proposals will be received by the West Chicago Park Commissioners, at office in Union Park, until Feb. 11, to furnish 1000, more or less, electric lamp-poles and switches for supporting the lamps to be used for illuminating the parks and boulevards under the control of the West Chicago Park Commissioners, in accordance with plans and specifications on file in office of electrical engineer, Foree Bain, 1657 Monadnock Block.

The Electric Railway.

PAINESVILLE, O.—An electric line will be completed to Painesville by June.

NAVOO, IA.—A movement is on foot to build an electric railway to connect with Fort Madison and Keokuk.

GREENVILLE, ALA.—A new short line is to be built in Alabama, between the towns of Miel and Greenville.

SALEM, ORE.—The Salem Consolidated Street Railway Company has passed into the hands of a receiver.

BALLSTON SPA, N. Y.—At a meeting of the Village Trustees all franchises for electric roads in the village were revoked.

NEW BRUNSWICK, N. J.—Work will soon be started on the new car-house to be erected by the Brunswick Traction Company.

WABASH, IND.—A movement is on foot to construct an electric railway line from Celina, O., to Rochester, Ind., a distance of 103 miles.

BROOKLYN, N. Y.—The Mayor of Brooklyn has declared himself to be in favor of granting the use of the Bridge Plaza to the electric railway companies.

WHITE PLAINS, N. Y.—The North Mt. Vernon Railway Company has applied for a franchise to construct a trolley road through Scarsdale, from Mt. Vernon to White Plains.

FORT DODGE, IA.—The Fort Dodge Electric Light & Power Company has completed its plans for the laying of the electric street railway. Work will be commenced about April 1. There will be about three miles of track laid this year.

PIERRE, S. D.—A survey was made for the proposed Pierre & Fort Pierre Street Railway. N. McGeorge, the projector, has secured the necessary equipment and says that he will have the road in operation early in the Spring.

BALTIMORE, MD.—Within a few days it is expected that work will be begun on the construction of the power house from which current is to be supplied for the Washington division of the new Columbia & Maryland electric railway.

RACINE, WIS.—The Milwaukee, Racine & Kenosha Street Railway Company has been incorporated with a capital stock of $1,000,000 The company will build an electric line from Cudahy to Racine and Kenosha and the Illinois State line.

PITTSBURG, PA.—The Allegheny Traction Company has had completed a preliminary survey for the extension of the Sharpsburg, Etna & Millville branch to Clenshaw. It has not been decided when work on the new extension will be commened.

ELIZABETH, N. J.—It is proposed to extend the tracks of the Middlesex & Union County trolley line from Rahway, through Linden to Elizabeth and thence to Summit. Later the south end of the line may be continued to Woodbridge, Maurers and Perth Amboy.

SAN FRANCISCO, CAL.—The Mill Valley & Mount Tamalpais Scenic Railway has organized to construct a mountain railway, and is to be eight miles long. Charles E. Green, Arthur A. Martin and David McKay, of San Francisco, and others are interested.

PELHAM, N. Y.—The Highway Commissioners of Pelham held a meeting to consider the application of the Mt. Vernon Railway Company for a franchise to lay tracks through Fourth Street from Mt. Vernon to the New Rochelle line It is probable that the franchise will be granted.

NEW HAVEN, CONN.—A meeting of the directors of the New Britain Central & Electric Company has been called for next week to take steps for the extension of its trolley road to Newington, to parallel both the New England and New Haven steam lines between New Britain and Hartford.

MOUNT McGREGOR, N. Y.—The Mount McGregor & Lake George Railway, which was sold by William J. Arkell to a syndicate headed by President Arnold, of the Union Electric Railway, of Saratoga, is to be extended to Glens Falls. Surveys are now being made around the base of Mount McGregor.

GOLDEN, COL.—At a meeting of the trustees of the town of Argo, a franchise was granted to the new railway company which proposes to build a line running through Globeville, Argo, Elyria and along the north side to connect with the West End Electric Line, thence through Jefferson County to Golden.

SALT LAKE CITY, UTAH.—The plans for a street railway to be operated by electricity, running on the east from Fifth Street to the penitentiary, connecting with lines running east of the city, are now in definite shape, and a franchise will soon be asked for. The company will be known as the East Bench, University & Southern.

WOBURN, MASS.—The Woburn Aldermen granted a location to the Woburn & Reading Street Railway Company. The proposed route is from the Reading & Woburn line through Washington, Cedar, Salem and Row Streets, Montvale Avenue, Main, New Boston, Valley and Middle Streets to Washington Street, there to join and complete a loop.

BUFFALO, N. Y.—The Buffalo Traction Company, whose application for a certificate to build a competing street railway was denied by the State Board of Railway Commissioners, made application to the Board of Aldermen to extend its line, known as the Elmwood Avenue & Tonawanda Electric Railway, into the city, over the route proposed in its application for a certificate.

PATCHOGUE, L. I., N. Y.—The Patchogue & Port Jefferson Traction Company has been organized at Patchogue. The company proposes to build a trolley road from Patchogue to Port Jefferson, 15 miles across the island. The capital is $400,000. The officers are: President. Edwin Bailey, Patchogue; President P. H. Flynn, of the Nassau Electric Railway, of Brooklyn, secretary, and Frank Miller, treasurer.

Trade and Industrial Notes.

I P. FRINK, 551 Pearl Street, New York, is much gratified at the appreciation his system of reflectors, so extensively used in this country, has received in foreign countries. Orders recently received have been from Paris, France; Berlin, Germany; Havana, Cuba; Monterey, Mexico, and Port Au Prince, Hayti.

PLANING MACHINES.—The Betts Machine Company, Wilmington, Del., in its 1896 catalogue gives a number of views of planing machines up to 120 inches travel A special machine illustrated and described is for planing frogs and switches, the machine being made especially powerful in view of the enormous duty imposed upon it.

THE STEARNS MANUFACTURING COMPANY, the widely-known manufacturers of electric light engines and boilers, Erie, Pa., has recently shipped three 200-hp compound and two simple engines to the Osaka Electric Light Company, Osaka, Japan, via the Northern Pacific Railway. This shipment reached its destination from Minnesota Junction in 28 days.

THE GARLOCK PACKING COMPANY, of Palmyra, N. Y., have recently placed on the market a high-pressure packing, designed and made to insure long service. The sectional and elastic ring packings and the spiral special water packings of this company are not only holding their own, but coming into even more general favor with engineers all over the country.

THE GENERAL ELECTRIC COMPANY has secured an order from the Cataract Construction Company for one 500-kw rotary converter for use in supplying current to the Buffalo & Niagara Falls Railway Company. The West End Street Railway Company, of Boston, has also just placed an order with the same company for four 1200-kw generators and one 1500-kw generator, making a total of 6300 kilowatts in five units.

THE DAVIS & EGAN MACHINE TOOL COMPANY, of Cincinnati, O. (formerly the Lodge & Davis Machine Tool Company), have just been awarded the medal for the best line of drill presses on exhibition at the Atlanta Exposition. This is quite a compliment, considering the high grade of machine tools exhibited there. This company has just received an order for one of its largest tools from the Lombard Machine Works & Supply Company, of Augusta, Ga.

GARRETT, MILLER & CO., of Wilmington, Del., have been quite successful in their telephone business of late, having installed several exchanges and private lines. An exchange at Dover, Del., of 100 instruments, reports its system as operating very satisfactory, and is increasing the number of 'phones daily. The above company have also been extensively engaged in electric lighting, making a specialty of ship and mill work. In a short time they will issue a catalogue on electrical supplies.

SINGLE-PHASE ALTERNATING-CURRENT POWER MOTOR.—One of the recent tests made by the Emerson Electric Manufacturing Company, of St. Louis, on a 1-hp size for 7200 alts. of their new type of power motor is claimed to have shown an efficiency of over 76.7 per cent. On a machine of this size and type this efficiency is quite remarkable, as it is considerably higher than the commercial rating. It is, however, always the policy of this company to keep on the safe side and well within actual results, believing that the trade appreciates such a method of doing business.

THE PENN BRIDGE COMPANY, contractors and manufacturers of bridges, roofs, and structural iron work, of Beaver Falls, Pa., is very busy both in its shops and in the field. It has contracts for a bridge across the Ohio River, between Rochester, Pa., and Monaca, Pa., of the suspension bridge type, which will be so constructed as to be adapted to the use of an electric railway if the same is desired at some future time. It is also building a bridge across the Ohio River at East Liverpool, O., and has on hand other minor contracts. It expects soon to be running double time.

THE MUNROE BOILER.—R. Munroe & Son, of the West Point Boiler Works, of Pittsburg, Pa., describe in a handsomely printed catalogue their safety water-tube boiler, which is stated to be the result of 35 years' experience in the designing and construction of all styles of boilers. The Munroe boiler is claimed to differ greatly from all other styles of boilers in that its construction makes it impossible for an explosion to occur; and that it is superior in circulation, in compactness, accessibility and several other points. In the absence of an illustration an idea may be given of the boiler by the statement that it is simply a tubular boiler turned inside out, water chambers at either end corresponding to the back and front connections respectively, the water tubes connecting these two chambers.

THE STANDARD BOILER.—The Standard Boiler Company, of Chicago, Ill., has issued a new catalogue, describing the Standard water tube safety boiler, manufactured by the Link-Belt Machinery Company, of Chicago, Ill. In a number of illustrations, all of the various details of design and construction are shown and also the manner of its installation. The boiler consists of a series of inclined tubes expanded into patent iron or wrought steel headers, each boiler having one or two flanged steel drums, the headers and drums being connected by circulating tubes. The drums are connected by an equalizing pipe, and the rear end headers are connected to a heavy iron mud drum. Among the claims made for the boiler are for its economy in the use of fuel, its freedom from possible explosion, from its having a perfectly free and unrestricted circulation, and the ease with which any part may be examined for cleaning and repairs.

MATHER DYNAMOS AND MOTORS.—Under the conservative management of Mr. Charles M. Jarvis, the sterling types of apparatus made at the Mather factory, Manchester, Conn., is finding renewed favor with purchasers. One of the latest large manufacturing plants to adopt electrical power transmission is the Keasbey & Mattison Company, makers of the well-known magnesia sectional covering, etc., at Ambler, near Philadelphia. This corporation has just closed a contract for a preliminary plant, consisting of a 60-kw, 200-volt multipolar Mather generator, and four slow-speed Mather motors of 30-hp capacity and less. One of the motors takes the place of an engine in an isolated department where steam has been carried by a pipe, covered with the owner's own magnesia covering. At the Keasbey & Mattison plant current is also generated for the town lighting-circuit. This lighting plant has just been increased by a third Mather ring-type dynamo.

THE YOUNGSTOWN BRIDGE COMPANY, Youngstown, O., has recently completed two bridges for the Mahoning Valley Electric Railway Company, near Girard, O., one of them being a 70-foot plate girder span, designed for the heaviest classes of electric motors. This company also has the contract for six bridges for the M. & C. Electric Railway Company, near Baltimore, Md., several of them being long double track plate girder spans. Among other notable bridges which are to carry electric cars is the Broadway Bridge at Denver, Col., which this company is just completing; this is 100 feet in width, consisting of plate girders 125 feet 4 inches long and 10 feet deep, each girder weighing about 50 tons. The entire roadway of the bridge is paved, and carries a double track for the Denver Tramway Company. The company has also under contract a large number of steel buildings covered with corrugated iron for power plants, among them being a steel building for a mining plant at Lordsburg, N. M., and a boiler and cast house for the Tonawanda Iron & Steel Company, North Tonawanda, N. Y.

AN EDITION DE LUXE.—The Germans have taken the lead in issuing trade publications printed and bound after the style of literary *editions de luxe*, but a recent Philadelphia publication brings this country well up to the front in this respect. The book to which we refer has been published by Messrs. Stern & Silverman, the well-known electric railway engineers, under the title of "The Superiority of Electric Storage-Battery Traction." It is a bound volume of almost 100 8 by-11-inch pages, the front cover being stamped with a colored design that would grace a volume of literary classics. The paper is of an extra fine quality, and the pages of letter press are ornamented each with two scroll-work corner pieces printed in colors. Numerous well printed half-tone engravings appear, illustrating more particularly the New York Madison Avenue storage-battery plant and cars; a number of line cuts are also used for plan views. In addition to the New York road, complete technical and illustrated descriptions appear of several Pennsylvania overhead trolley roads installed by Messrs. Stern & Silverman. Though avowedly a trade publication in the interests of these gentlemen and the Electric Storage Battery Company, the volume nevertheless takes high rank as a technical treatise on the subject of which it treats.

THE D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn., is extremely gratified with the increase of its business during 1895 over the preceding year, being in actual figures 84 per cent. In looking over their books to account for this figure, which is astonishing even to the members of the firm, it was noted that the customers, with scarcely a single exception, had largely increased their orders for the number of pieces of patent lava insulation, as well as having added other pieces to their list. In addition, a large number of new customers were obtained during the year, but ultimately the uniform excellence and absolute reliability under the most trying conditions of the lava insulation accounts for all. A letter from a well-known manufacturer of electrical apparatus in New York, accompanied by some slate models of insulators to be reproduced in lava, contains the statement that "slate is useless as an insulator, as a current after passing through the induction coil will short-circuit right through that material." During the many years the Steward Manufacturing Company have been making literally millions of pieces of lava insulation, they state they have never been confronted by any such statement concerning lava, having yet to hear of a single case of its failure under most trying conditions.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 15 South Warren Street, Syracuse, N. Y.

IRRIGATION IN DAKOTA is causing that much maligned section of the Western country to blossom like the rose. Quoting from a published article on the subject, it is stated that "Men who are accustomed to farming in non-irrigated districts are slow to believe the reports of enormous yields of all kinds of farm products in those sections of the country where irrigation is practiced." An irrigated 40 acre farm produces greater and better results than a 640 acre farm cultivated in the ordinary way. In a few weeks we hope to be able to publish various items from different individuals giving their personal experience in irrigation farming.

In the meantime send for a free copy of an illustrated pamphlet in reference to Irrigation in Dakota, published by the Chicago, Milwaukee & St. Paul Railway Company. Address, E. F. Richardson, General Agent, Passenger Department, New York City.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JAN. 28, 1896.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

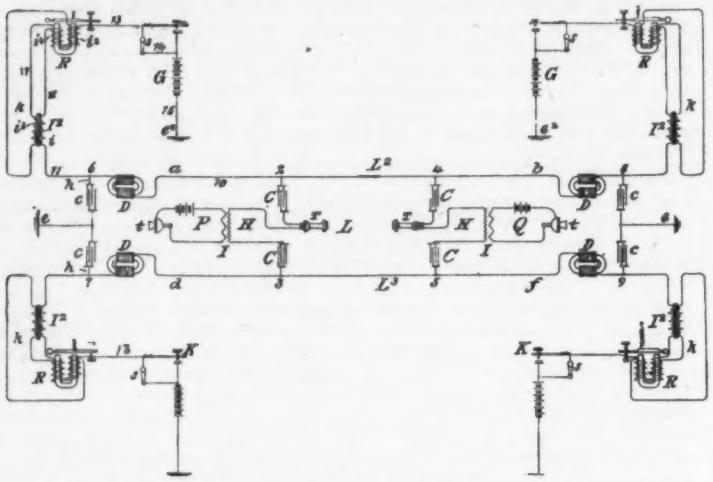
553,528. LIGHTNING ARRESTER; E. G. W. C. Hoffman, Charlottenburg, Germany. App. filed Sept. 3, 1895. A lightning arrester for electric conductors comprising primary and secondary arrester devices in circuit between the conductor and the earth and a solenoid magnet interposed in circuit with the two arrester devices, and controlling the arc of the primary arrester device; the secondary arrester having a fusible body interposed between its opposite plates or portions to facilitate the passage of the electric discharge.

553,529. METHOD OF ELECTRICAL PROPULSION FOR STREET AND OTHER CARS; J. Jackson, Clinton, Iowa. App. filed Nov. 10, 1893. In an electric railway, the combination with a main line conductor, and a plurality of contact devices disposed at intervals along the conductor, said conductor being provided with denuded sections opposite each contact device, and housings of insulating material, which completely cover the denuded portions of the conductor, and which embrace movable parts or sections adapted to be moved out of the path of the movable parts of the contact devices to permit the approach of the same to the denuded portions of the conductor.

553,535. TELEGRAPH REPEATER; B. F. Merritt, Newark, N. J. App. filed May 20, 1895. In a telegraph repeater the combination with a pair of polarized relays, of an automatic locking relay having a pair of vibrating levers adapted to move in the path of the other.

553,538. RHEOSTAT; W. H. Morgan, Alliance, O. App. filed Nov. 21, 1891. In a rheostat the combination with a base, a resistance medium carried thereby, and a series of metal plates partially embedded in said resistance medium of a movable contact carried by the base, and adapted to engage the plates.

553,552. ELECTRIC RAILWAY CONDUIT; A. Beck, Atlanta, Ga. App. filed Nov. 2, 1894. In an electric conduit a series of metallic frames, provided with slots or openings in their tops, bars secured to the frames, a plate rigidly secured to the top of the frames, upon one side of the slot, and plates removably applied to the top of the frame upon the opposite side of the slot, which plates are provided with vertical flanges upon their edges for the purpose of holding them in position upon the frames.



No. 553,605.—Composite Telegraph and Telephone Transmission.

553,557. ARMATURE FOR ELECTRIC MACHINES; R. M. Gardner, Chicago, Ill., App. filed May 27, 1895. The combination of a series of coils, each of which has an inner end turned laterally to project from beneath the coil, and both this projection and its outer end freed from the insulation, and a series of commutator segments, each of which has a projecting arm, a portion of which extends to and is tightly clamped upon the inner end of one coil, and another portion extends to, and is tightly clamped upon the outer end of the adjacent coil.

553,596. SECONDARY BATTERY; P. F. Ribbe, Berlin, Germany. App. filed July 10, 1895. In a double electrode for storage batteries, the combination with two plates of non-conducting material, having recesses in the outer surfaces, and recesses in the inner adjacent surfaces, in which inner recesses some are dovetailed, and an acid resisting substance cast in between the plates and their inner recesses to hold the two plates together.

553,605. COMPOSITE TELEGRAPHIC AND TELEPHONIC TRANSMISSION; E. E. Backus, New York, N. Y. App. filed June 17, 1895. The combination of a telegraphic circuit main line constituting one conductor of a double wire telephone circuit with a double wire relay, and an induction coil, one winding of both being serially included in the main circuit, and the other winding of said relay and induction coil being joined up serially in a short closed circuit; whereby the effects of dissipative discharges passing from the line to the earth through one winding of the relay, may be nullified by induced currents developed by such discharges, and passing through the other winding of said relay.

553,633. ANTISEPTIC DIAPHRAGM FOR TELEPHONES; E. Weschcke, San Francisco, Cal. App. filed May 9, 1895. In a telephone or speaking-tube a diaphragm composed of a fabric capable of absorbing an antiseptic, cut into discs of suitable size to fit over the mouthpiece of a speech or sound transmitter instrument, and an annular cap adapted to press the edges of said diaphragm against the mouthpiece while using.

553,635. UNDERGROUND TROLLEY SYSTEM; N. H. Anspach, Chicago, Ill. App. filed Aug 20, 1895. In an underground trolley system the combination of a slotted conduit, a housing in the conduit formed with a diaphragm base, resilient sides supported on the diaphragm, and a metal presser bar supported underneath the conduit-slot, for engagement by the trolley, by said sides to form the cover of the housing and a service conductor inclosed in the housing, and extending into proximity to contact with said bar by pressing the latter against said service conductor.

553,637. ELECTRIC ARC LAMP; E. J. Bagnall and G. Arnold, Cleveland, O. App. filed Oct. 2, 1895. In an arc lamp the combination with a separate magnet and the carbons, of a pivoted lever connected with the armature of said magnet, and connection between said lever and the carbons, a curved lever normally disposed in the path of the first-mentioned lever and a spring bearing against said curved lever, and adapted to control the movements of the same.

553,642. REGISTER; T. B. Dixon, Henderson, Ky. App. filed Aug. 20, 1894. The combination with a block or section of track, signals and signal operating mechanism therefor, and a track instrument operated by the passage of a train over said track, of a register having suitable vessels with a divisible substance therein, mechanism operated by the track-instrument, and arranged to transfer from one vessel to another a quantity of the divisible substance proportional to the number of times the track-instrument is operated.

553,673. INCANDESCENT LAMP; H. Green, Hartford, Conn. App. filed April 16, 1895. In an electric lamp, the combination with a bulb having electric conductors therein; of a filament connected to said conductors, and bent to form an enlarged loop under tension, and bent out of its normal first loop position into abnormal transverse position to form a second enlarged loop, under relatively high spring tension, whereby said filament has a constant tendency to spring back toward its normal first loop position, and means for holding said filament in its abnormal position, and thereby prevent said filament from springing back toward its normal first loop position, and whereby vibration thereof is substantially eliminated.

553,675. ELECTROMAGNET; C. D. Haskins, Brooklyn, N. Y. App. filed May 18, 1889. An electromagnet with two insulated conductors in concentric sections or helices, each conductor including an inner and outer section or helix.

553,697. ELECTRIC ARC LAMP; H. O. Swoboda and E. Lavens. App. filed Sept. 6, 1894. In an electric lamp, the combination of a movable frame, a rock shaft provided with an arm also carried by said frame, a stop for co-acting the said arm, and an adjustable weight or weights secured to the movable frame.

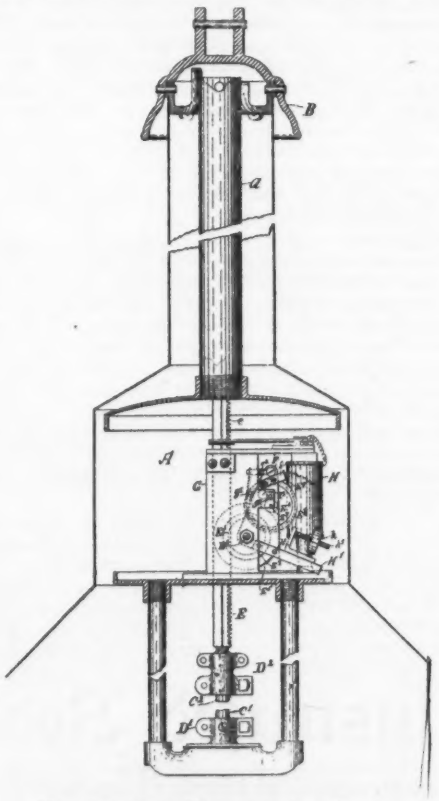
553,719. ELECTRIC BATTERY; Johan W. Th. Olan, New York, N. Y. App. filed Aug. 5, 1892. An electric battery having its positive pole composed of metal, a negative pole consisting of mercury in combination with substances adapted to form with hydrogen non-gaseous compounds, and an electrolyte between the poles.

553,730. ELECTRIC SWITCH; J. C. Fagan, Watertown, N. Y. App. filed May 6, 1895. Consists of a switch lever provided with contacts, and having a recessed or grooved piece of insulating material intermediate of its length, and insulating the said contacts from each other, and a fuse connecting said contacts, and lying in said recess.

553,733. AUTOMATIC REPEATING RAILWAY SIGNAL; R. H. Innes, San Antonio, Texas. App. filed March 30, 1895. An automatic repeating railway signal, comprising a rotary device for shifting the signal, a disc loosely mounted on the shaft of said shifting device, and having means to lock the said shifting device and disc into operative engagement, and a key adapted to be actuated from the said disc to send messages to the central station.

553,736. ELECTRIC RAILWAY SYSTEM; J. F. Page, Chewacla, Ala. App. filed June 28, 1895. In an electric railway system, the combination of a track, a feed wire having a series of normally open branches, terminating in contact plates suitably located along the track, a return conductor having two sets of normally open branches, connected respectively to the respective track-rails, and means for closing the circuit through the respective branches of the feed and return conductors.

553,799. ELECTRIC RAILWAY; M. L. Wood, United States Navy. App. filed Sept. 12, 1894. An electric conductor and means for supporting same comprising a rail flanged at the top, blocks of insulating material adapted to slide on said rail, and to engage beneath said flange, said blocks being provided with longitudinal grooves in the sides thereof, and a sheath provided with outwardly projecting flanges adapted to engage in said grooves, with clips adapted to support said outwardly projecting flanges.



No. 553,697.—Electric Arc Lamp.

553,819. CONTROL SYSTEM FOR ELECTRIC MOTORS; G. Sautter, J. M. L. Savatier, and C. E. DeLagabbe, Paris, France. App. filed Sept. 21, 1893. The combination with the electromotor and the supply conduit thereof, of two circuit closers controlling contacts in said circuit for sending current through the same in either direction, auxiliary speed-controlling circuit closers, controlling resistances in said circuit, an exciting circuit having branches, each including the actuating magnet of one of said circuit closers and switching mechanism comprising a movable switch arm and stationary terminals in said exciting circuit arranged on opposite sides of the normal position of said switch arm.